

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

AD-A023 608

VALIDATION OF THE AMC-71 MOBILITY MODEL

APPENDIX A: VEHICLE DATA. APPENDIX B:

LOCATION AND DESCRIPTION OF TEST SITES.

APPENDIX C: DEFINITIONS OF TERRAIN

TERMS AND PROCEDURES USED TO COLLECT

TERRAIN DATA FOR VALIDATION TESTS.

APPENDIX D: BASIC TERRAIN DATA

ARMY ENGINEER WATERWAYS EXPERIMENT STATION

MARCH 1976



TECHNICAL REPORT AL-76-5

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March 1976

Final Report

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APPENDIX A: VEHICLE DATA

1. Data required for each vehicle as input to the AMC-71 Mobility Model are contained in Table A1. Photos of the vehicles are shown in Figure 3 in the main text.

Table A1

Vehicle Characteristics

No.	Vehicle Characteristics Identification	Dimensions	Test Vehicles				
			M151	M35A2	M113A1	M48	M60
1	Vehicle type (0 for tracked and 1 for wheeled)	-	1	1	0	0	0
2	Gross vehicle weight (cross country)	lb	3180	18,225	23,410	104,000	93,620
3	Weight on powered axles	lb	3180	18,225	NA*	NA	NA
4	Track type (0 for flexible and 1 for girdalized)	-	NA	NA	0	0	0
5	Grouser height for tracks; number of tires for wheels (duals as two)	in.	4	6	1.0	1.5	1.5
6	Tire ply rating	-	6	12	NA	NA	NA
7	Gross rated horsepower	bhp	71	140	215	750	750
8	No. of tracks or tires (duals as two)	-	4	6	2	2	2
9	No. of tracks or tires (duals as one)	-	4	6	2	2	2
10	No. of axles	-	2	3	NA	NA	NA
11	Vehicle width	in.	62.25	96	105	143	143
12	Vehicle length	in.	132	280.6	192	270.5	273
13	Track width or nominal tire width	in.	7	11	15	28	28
14	Wheel rim diameter	in.	16	20	NA	NA	NA
15	Recommended tire pressure (highway)	psi	20 ft** 25 rr**	70	NA	NA	NA

(Continued)

* Not applicable.

** ft = front tire pressure; rr = rear tire pressure.

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Table A1 (Continued)

No.	Vehicle Characteristics Identification	Dimensions	Test Vehicles				
			M151	M35A2	M113A1	M48	M60
16	Recommended tire pressure (cross-country)	psi	18 ft 22 rr	35	NA	NA	NA
17	Recommended tire pressure (sand)	psi	12 ft 18 rr	15	NA	NA	NA
18	Area of one track shoe (tracked) or No. of wheels (wheeled)	in. ²	4	6	90	194	194
19	No. of bogies in contact with ground (tracked) or chain indicator (wheeled)-- 0 for no chains and 1 for chains	-	0	0	10	12	12
20	Vehicle ground clearance at center of greatest wheel span	in.	13.2	21.5	16	16	18
21	Minimum vehicle ground clearance	in.	8.8	12.5	16	16	18
22	Rear-end clearance (vertical clearance of vehicle's trailing edge)	in.	18	32	23	41	40
23	Vehicle departure angle	deg	37	40	40	40	42.5
24	Vertical clearance of vehicle's leading edge	in.	19	39	30	45	45
25	Vehicle approach angle	deg	66	42	70	90	90
26	Length of track on ground or wheel diameter	in.	30	42	105	161.5	171
27	Height of vehicle pushbar	in.	19	39	30	45	45

(Continued)

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Table A1 (Continued)

No.	Vehicle Characteristics Identification	Dimensions	Test Vehicles				
			M151	M35A2	M113A1	M48	M60
28	Distance between first and last wheel center lines (or bogies)	in.	85	178	105	157.5	167
29	Horizontal distance from center of gravity to the front-wheel vertical center lines	in.	45	101.4	52	77.5	77.2
30	Vertical distance from center of gravity to the road-wheel horizontal center line	in.	10	23	24	26.3	36
31	Maximum span between adjacent wheel center lines	in.	85	130	NA	NA	NA
32	Angle between a line parallel to the ground surface and the line connecting the center of gravity and the center of the rear road wheel or idler (the wheel used to determine departure angle)	deg	NA	NA	18.4	5.5	25.9
33	Direct distance from the center of gravity to the center of the rear idler or rear sprocket	in.	NA	NA	91.0	120	120.7
34	Vertical distance from the ground to the center of the rear sprocket or rear idler	in.	NA	NA	15	41	43
35	Track thickness plus the radius of the rear sprocket or rear idler	in.	NA	NA	11	15.25	15.25
36	Track thickness plus the road wheel radius	in.	NA	NA	14.5	17.0	17.0

(Continued)

(Sheet 3 of 7)

Table A1 (Continued)

No.	Vehicle Characteristics		Dimensions	Test Vehicles				
	Identification			M151	M35A2	M113A1	M48	M60
37	Rolling radius of tire or sprocket pitch radius	in.		14.2	20.1	9.8	12.25	12.25
38	Height of rigid point used to determine approach angle	in.		19	39	23	45	45
39	Maximum braking force vehicle can develop divided by vehicle weight	-		0.8	0.8	0.8	0.8	0.8
40	Loaded wheel radius	in.		14.2	20.1	NA	NA	NA
41	Distance vehicle spans before significant motion begins	in.		15	21	49.7	70	67
42	Maximum force pushbar can withstand	lb		3180	18,225	55,000	208,000	185,000
43	Maximum axle load/gross vehicle weight (0.5 is maximum)	-		0.5	0.33	NA	NA	NA
44	Vehicle rated horsepower per ton	hp/ton		44.7	15.4	18.4	14.4	16.0
45	Transmission type (0 for automatic and 1 for manual)	-		1	1	0	0	0
46	Final drive-gear ratio	-		4.86	6.27	3.93	5.08	5.08
47	Final drive-gear efficiency	-		0.9	0.9	0.95	0.98	0.9
48	Number of gears in transmission	-		4	10	3	2	2

(Continued)

(Sheet 4 of 7)

Table A1 (Continued)

No.	Vehicle Characteristics Identification	Dimensions	Test Vehicles				
			M151	M35A2	M13A1	M4B	M60
49	Gear ratios for transmission	-	5.712, 3.179, 1.674, 1.00	9.94, 5.5, 5.02, 3.21, 2.78, 1.98, 1.62, 1.56, 1.00, 0.79	3.79, 1.931, 1.00	3.497, 1.254	3.497, 1.256
50	Transmission efficiency	-	0.9	0.9	0.95	0.98	0.9
51	Number of point pairs in net engine torque versus engine speed curve	-	10	9	12	15	15
52	Array containing net engine torque versus engine speed curve	-	800, 115, 1200, 115, 1600, 115, 2000, 115, 2400, 112, 2800, 108, 3200, 103, 3600, 96, 4000, 88, 4400, 80	1000, 325, 1200, 325, 1400, 325, 1600, 324, 1800, 320, 2000, 310, 2200, 300, 2400, 285, 2600, 270	600, 158.9, 800, 309.4, 1000, 379.4, 1200, 410.3, 1400, 419.9, 1600, 417, 1800, 406.7, 2000, 391.7, 2200, 374.1, 2400, 355.1, 2600, 335.6, 2800, 316.1	1000, 1500, 1100, 1540, 1200, 1610, 1300, 1640, 1400, 1670, 1500, 1680, 1600, 1680, 1700, 1670, 1800, 1650, 1900, 1630, 2000, 1600, 2100, 1560, 2200, 1515, 2300, 1470, 2400, 1420	1000, 1500, 1100, 1560, 1200, 1610, 1300, 1640, 1400, 1670, 1500, 1680, 1600, 1680, 1700, 1670, 1800, 1650, 1900, 1630, 2000, 1600, 2100, 1560, 2200, 1515, 2300, 1470, 2400, 1420
53	Gear ratio from engine to torque converter	-	NA	NA	1	0.862	0.862
54	Denotes presence of a torque converter lockup (No = 0, Yes = 1)	-	NA	NA	1	0	0
55	Input torque at which the torque converter curves were measured	ft-lb	NA	275	900	900	900

(Continued)

(Sheet 5 of 7)

Table A1 (Continued)

Vehicle Characteristics				Test Vehicles		
No.	Identification	Dimensions	M151 M35A2	M113A1	M48	
56	Number of point pairs in array containing torque converter input speed versus converter torque ratio curve	-	NA	24	12	
57	Array containing torque converter input speed versus converter torque ratio curve	-	NA	0.2340, 0.05, 2320, 0.1, 2300, 0.15, 2280, 0.2, 2260, 0.25, 2250, 0.3, 2240, 0.35, 2230, 0.4, 2230, 0.45, 2240, 0.5, 2250, 0.55, 2270, 0.6, 2300, 0.65, 2340, 0.7, 2400, 0.75, 2490, 0.8, 2620, 0.85, 2840, 0.9, 3160, 0.91, 3280, 0.92, 3400, 0.93, 3600, 0.94, 4000, 1.5000	0.1875, 0.1, 1850, 0.2, 1825, 0.3, 1815, 0.4, 1830, 0.5, 1895, 0.6, 1970, 0.7, 2030, 0.8, 2130, 0.85, 2210, 0.9, 2500, 1.0, 50000	0.1875, 0.1, 1850, 0.2, 1825, 0.3, 1815, 0.4, 1830, 0.5, 1895, 0.6, 1970, 0.7, 2030, 0.8, 2130, 0.85, 2210, 0.9, 2500, 1.0, 50000
58	Number of point pairs in array containing torque converter torque multiplying coefficient versus converter speed ratio curve	-	NA	21	21	
59	Array containing torque converter torque multiplying coefficient versus converter speed ratio curve	-	NA	0.3, 31, 0.05, 3.16, 0.1, 2.99, 0.15, 2.8, 0.2, 2.58, 0.25, 2.38, 0.3, 2.19, 0.35, 2.02, 0.4, 1.87, 0.45, 1.73, 0.5, 1.6, 0.55, 1.49, 0.6, 1.38, 0.65, 1.28, 0.7, 1.18, 0.75, 1.07, 0.8, 0.98, 0.85, 0.98, 0.9, 0.98, 0.95, 0.97, 1.0, 0.9	0.3, 65, 0.05, 3.55, 0.1, 3.25, 0.15, 2.87, 0.2, 2.66, 0.25, 2.46, 0.3, 2.28, 0.35, 2.12, 0.4, 1.96, 0.45, 1.82, 0.5, 1.67, 0.55, 1.54, 0.6, 1.42, 0.65, 1.32, 0.7, 1.22, 0.75, 1.14, 0.8, 1.05, 0.85, 0.98, 0.9, 0.97, 0.95, 0.95, 1.0, 0.93	0.3, 65, 0.05, 3.55, 0.1, 3.25, 0.15, 2.87, 0.2, 2.66, 0.25, 2.46, 0.3, 2.28, 0.35, 2.12, 0.4, 1.96, 0.45, 1.82, 0.5, 1.67, 0.55, 1.54, 0.6, 1.42, 0.65, 1.32, 0.7, 1.22, 0.75, 1.14, 0.8, 1.05, 0.85, 0.98, 0.9, 0.97, 0.95, 0.95, 1.0, 0.93

(Continued)

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Table A1 (Concluded)

No.	Vehicle Characteristics Identification	Dimensions	Test Vehicles				
			Q151	Q153	Q134	Q1	Q60
60	Number of point pairs in vehicle velocity versus obstacle height at 2.5-g vertical acceleration curve	-	26	17	19	30	24
61	Array containing vehicle speed versus obstacle height 2.5-g vertical acceleration curve	-	1,30,2,16,667, 3,10,4,7,143, 5,5,56,6,4,543, 7,3,446,8,3,333, 9,2,941,10,2,632, 11,2,381,12,2,174, 13,2,14,1,652, 15,2,724,16,1,613, 17,1,515,18,1,429, 19,1,351,20,1,262, 21,1,25,22,1,163, 23,1,11,24,1,064, 25,1,02,100,1	0,50,5,30, 7,35,8,26,8, 9,21,2,10,10,7, 1,13,8,12,10,5, 13,7,8,14,5,6,5, 15,5,16,3,7, 17,2,8,18,2,1, 19,2,5,20,1,2, 21,1,7,22,1,4, 23,1,3,24,1,1, 100,1	0,1,50,6,50, 9,31,3,10,18, 11,12,3,12,9,1, 13,7,1,14,5,7, 15,4,7,16,3,9, 17,3,3,18,2,8, 19,2,3,20,2, 21,1,7,22,1,4, 23,1,3,24,1,1, 100,1	0,60,9,60, 10,12,2,11,6,9, 12,6,13,5,6, 14,5,4,15,5,3, 16,5,2,17,5,2, 18,5,1,19,5,1, 20,5,21,5, 22,5,23,5, 24,5,25,1,9, 26,4,9,27,4,9, 28,4,9,29,4,9, 30,4,9,31,4,9, 32,4,9,34,4,9, 36,4,9,37,4,9, 38,4,9,100,4,8	0,60,9,60, 10,12,2,11,6,9, 12,6,13,5,6, 14,5,4,15,5,3, 16,5,2,17,5,2, 18,5,1,19,5,1, 20,5,21,5, 22,5,23,5, 24,5,25,1,9, 26,4,9,27,4,9, 28,4,9,29,4,9, 30,4,9,31,4,9, 32,4,9,34,4,9, 36,4,9,37,4,9, 38,4,9,100,4,8
62	Number of point pairs in ride dynamics versus speed curve	-	10	10	10	10	10
63	Array containing ride dynamics speed curve	-	0,66,0,2,30, 1,39,2,20, 3,13,5,4,10, 5,7,5,6,6,3, 7,5,3,8,5	0,56,0,2,40, 1,25,2,19, 3,4,4,11,3, 5,9,6,7,5, 7,6,3,8,5,2	0,40,0,2,40, 1,32,2,15,3, 3,7,4,4,9, 5,3,7,6,3,1, 7,3,8,3	0,30,0,2,30, 3,30,3,4,26, 4,22,4,6,19, 5,8,5,7,12, 8,10,10,7	0,30,0,2,30, 1,30,2,30, 3,30,4,24,5, 5,20,6,16,8, 7,14,2,8,12

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APPENDIX B: LOCATION AND DESCRIPTION OF TEST SITES

1. To verify the performance predictions from AMC-71 Ground Mobility Model satisfactorily, a variety of sites in which to conduct tests to meet the requirements of the validation program were required. Test sites were selected from the results of reconnaissance of several military reservations and other sites with a variety of terrain conditions, accessibility, and proximity to maintenance areas. Sites selected were at Fort Sill, Oklahoma; Yuma Proving Ground, Arizona; Eglin AFB, Florida; Houghton, Michigan; and Fort Knox, Kentucky. Locations of the traverses and single terrain units tested are shown in Figures 4-9 in the main text. A general description of each of the test sites is given in the following paragraphs, and a profile with photos of each of the test traverses is shown in Plates B1-B17. The terrain units described are those that were outside the traverses. All soil types described in the following paragraphs are in terms of the Unified Soil Classification System (USCS).

Fort Sill Traverses and Terrain Units

Traverses

2. All four traverses at Fort Sill were within the Fort Sill Military Reservation, near Lawton in south-central Oklahoma. Three of the traverses were composed of characteristic prairieland terrains; the other course was composed primarily of large stands of relatively dense hardwood trees. The soil type in the area was mainly lean clay (CL).

3. Traverse 1. This traverse, the longest at Fort Sill, was 11,350 ft long. Most of the terrain comprising the traverse was rolling grassland. However, along the drainageways the vegetation density and size increased, with some trees included. The soil was lean clay with some rocks and boulders.

4. Traverse 2. This traverse was 8150 ft long and composed of rolling grassland. Along the drainageways vegetation density and size

increased, with some trees. The soil was lean clay with some rocks and boulders.

5. Traverse 3. This traverse was 6750 ft long. The first 2401 ft was a relatively dense stand of oaks and other hardwoods. The remainder was rolling grassland with some areas of rugged terrain near rock outcroppings. The soil was lean clay with some rocks and boulders, especially near outcroppings.

6. Traverse 4. This traverse, near the end of Traverse 1, was 5300 ft long. The entire traverse was rolling grassland with no trees. The soil was lean clay with scattered rocks.

Terrain units

7. Terrain units 0-1 and 0-2. These terrain units had a soil classification of lean clay with a 100 percent cover of grass 6 in. high at the time of testing. Terrain unit 0-1 had a surface slope of 3.3 percent and terrain unit 0-2, a slope of 7.4 percent.

8. Terrain unit 0-3. This unit had a 100 percent cover of 6-in.-high grass and a soil type of lean clay with a few small rocks. It had a 13.7 percent slope.

9. Terrain units 0-4 and 0-5. These terrain units had a 70 percent cover of 48-in.-high grass and a soil type of lean clay with numerous small rocks. Terrain unit 0-4 had a 27.2 percent slope, and terrain unit 0-5 had a 31.5 percent slope.

10. Terrain unit 0-6. This unit had a 95 percent cover of 6-in.-high grass with a soil type of lean clay with a few scattered small rocks. The slope was 17.8 percent.

11. Terrain unit 0-7. This nearly level terrain unit, near the end of Traverse 2, was 100 percent covered with grass and was of relatively firm lean clay. Grass heights varied up to 36 in.

12. Terrain unit 0-8. This terrain unit, near the main base, was a very firm area of moved Bermuda grass with terrain slope of 0.47 percent.

13. Terrain unit 0-9. This unit was relatively firm and open with uniformly spaced scrub oaks. Ground cover was 60 percent grass up

to 12 in. high on a soil classified as silty clay. The slope was 0.4 percent.

Yuma Traverses and Terrain Units

Traverses

14. Five of the six traverses at Yuma were within the boundaries of Yuma Proving Ground, 24 miles northeast of Yuma in southwestern Arizona. One traverse was in the dune area of the Sand Hills in southeastern California, 20 miles west of Yuma.

15. Traverse 1. This traverse, 19,877 ft long, was the longest of six traverses. It was purposely chosen for testing because it encompassed the entire range of materials found at the Yuma sites; namely, dunes, undulating hills, smooth and rough washes, desert pavement, and some of the denser desert vegetation. The soils were mixtures of alluvial sand, gravel, and sandy silt. Desert pavement areas at the ends of this traverse consisted of pebbles on undisturbed apron surfaces overlying silt and sand mixtures. These apron surfaces were drained by many branching and braided ephemeral washes. Bouldery and gravelly materials mixed with sands and silts were in the washes. Along the washes were the denser areas of vegetation in the traverse, with clusters of trees up to 30 ft tall scattered throughout the wash areas. The central portion of traverse was an area of undulating silty and hills bordered by microdunes with a sparse growth of desert vegetation.

16. Traverse 2. This traverse was in a hilly area near Traverse 1 and was 2902 ft long. It was basically a gently sloping area of sand, silt, and gravel with an occasional clump of vegetation or a small wash. No desert pavement areas were included in the traverse.

17. Traverse 3. Located southeast of Traverses 1 and 2, Traverse 3 was on a broad alluvial apron in the Castly Dome Plain. The entire 8971-ft course was relatively flat, though numerous washes crossed it. Desert pavement areas comprised the bulk of the traverse, scattered between the wash areas or clumps of vegetation. Soils were

mostly silty sand with large quantities of bouldery and gravelly materials.

18. Traverse 4. This traverse, some 6 miles to the east of Traverse 3, generally followed a broad smooth wash for 6000 ft. The initial 1600 ft and final 1700 ft of the traverse were broad, flat wash areas of sandy, gravelly silt with some large boulders and dead vegetation. The remainder of the traverse followed a relatively smooth wash. The wash bottom was composed of fine, smooth pebbles mixed with sandy silt and a few boulders. Trees up to 30 ft tall, mixed with scrub desert vegetation, grew along the wash bottom.

19. Traverse 5. This traverse was some 40 miles to the west of the above traverses in the Sand Hills area of southeastern California. Most of the 6966-ft traverse was in an area of wind-blown dunes up to 20 ft high with sparse desert vegetation. The soil was primarily clean sand, though in some areas of exposed desert floor the soil was a mixture of sand and silt.

Terrain units

20. Terrain units 0-1 through 0-13. These terrain units were relatively firm areas of bouldery gravel, near Pole Line Road east of Traverse 4. Surface slopes ranged from 24.9 to 61.6 percent with little or no vegetation.

21. Terrain units 0-14 through 0-36. These terrain units were areas of coarse sand near Traverse 1. Slopes ranged from 10.0 to 49.7 percent with little or no vegetation.

22. Terrain units 0-37 through 0-46. This group of terrain units was in the sand dune area of the Sand Hills in California. They were composed of fine, clean sand slopes ranging from 8.5 to 43.0 percent with no vegetation.

23. Terrain unit 0-47. This unit was 800 ft long, at the end of Traverse 4. The soil was a mixture of gravel, sand, and silt. The surface slope was 0.9 percent with some scrub vegetation.

24. Terrain unit 0-48. This unit was 646 ft long, south of Pole Line Road between Traverses 3 and 4. The soil was a silty sand; the

scattered clumps of desert vegetation ranged from small shrubs to large cacti. Terrain surface slope was 0.6 percent.

25. Terrain unit 0-49. This unit of desert pavement was near the beginning of Traverse 1 in an area nearly void of vegetation. This terrain was covered with a sandy silt overlain with 1- to 2-in.-diam washed brownish-black rocks.

26. Terrain unit 0-50. This terrain unit was near Traverse 2. It was level and composed of silty, gravelly sand with little or no vegetation.

27. Terrain unit 0-51. In a clean dune area, this terrain unit was a clean sand with sparse scrub vegetation.

28. Terrain unit 0-52. This level sand flat was located 1/4 mile east of the dunes. The desert floor material was a mixture of sand and silt with sparse vegetation.

29. Terrain unit 0-53. In a clean dune area at the end of Traverse 5, this terrain unit was a clean, windward, sandy slope of 12.1 percent with no vegetation.

30. Terrain units 0-54 through 0-64. These units were along a gravelly wash parallel to the slope test area (0-1 to 0-13), near Pole Line Road east of Traverse 4. The units contained obstacles of various geometric shapes and sizes mainly of sandy silt with some sparse desert vegetation.

Eglin AFB Traverses and Terrain Units

Traverses

31. All three traverses at Eglin AFB were in the northwest corner of the base, east of Pensacola in the western panhandle of Florida. The traverses were in an area known as Airfield 6, used as a training area by the U. S. Army Ranger Training School at Eglin. The traverses were composed of various combinations of pines and scrub oaks, with mixed shrubs, in poorly graded sands with some fines which were classified as SP according to the USCS.

32. Traverse 1. This traverse, adjacent to one of the runways of Airfield 6, was 3857 ft long. The first 700 ft of the course was composed of small scrub oak trees; the remainder consisted of large stands of pine trees with some scrub oak and palmetto mixed with small underbrush.

33. Traverse 2. East of Airfield 6 and parallel to the main runway of the airfield, this traverse was 5668 ft long, the longest of the three traverses at Eglin. The traverse encompassed a large variety of terrain conditions, including tall, thick stands of pine, thick scrub oak areas, and areas containing tree-length logs of varying diameters. In most areas, especially near pine stands, the ground surface was completely covered with thick pine straw, which allowed little or no vegetation growth at ground level.

34. Traverse 3. Directly south of Traverse 1, this traverse was 3588 ft long. The vegetation was generally the same as that of the other traverses, with generally more open areas underneath large pine stands.

Terrain units

35. Terrain units 0-1 and 0-4. These two terrain units were relatively bare, with little or no slope. Soil in terrain unit 0-4 was firm sand and in terrain unit 0-1, near a trail, was somewhat disturbed loose sand.

36. Terrain units 0-2 and 0-5. Small shrubs and several trees were cut from an area adjacent to Traverse 3 to provide a suitable area for terrain units 0-2 and 0-5. These two terrains were adjacent to each other in relatively soft sand with a 2- to 3-in.-thick layer of ground litter composed of pine straw and oak leaves.

37. Terrain units 0-3 and 0-6. These two terrain units were in an area of very large pines with little or no underbrush. Ground cover was nearly 100 percent pine straw. The soil of terrain unit 0-6, which was near a small drainageway, was less firm than that of terrain unit 0-3.

38. Terrain unit 0-7. This terrain unit, in the same terrain as unit 0-1 of Traverse 1, was modified from the existing terrain by removing all scrub oaks in an area large enough for vehicle testing. After removal of the trees, the only vegetation remaining was short grass with some ground litter.

39. Terrain unit 0-8. In a thickly vegetated area near the Yellow River, this 354-ft-long terrain unit was composed of nearly all vegetation types common to the overall test area, including pines, oaks, palmetto, and various low shrubs, with thick grass and pine straw on the ground. The area contained some surface roughness.

40. Terrain unit 0-9. This short terrain unit was near the Yellow River in an area of extremely thick vegetation. The thick titi trees with numerous branches and exposed roots, intermingled with tall pines and stumps, created an area nearly impossible to penetrate. The soft ground surface was composed of decayed vegetation and mosses atop the sandy soil.

41. Terrain unit 0-10. Adjacent to Traverse 2, this terrain unit, 210 ft long, had tall pines, scattered oaks, and little or no ground vegetation. The soft sandy soil was nearly 100 percent littered with pine straw and decayed leaves.

42. Terrain unit 0-11. This terrain unit was 1000 ft long and was adjacent to the end of the longest of the runways at Airfield 6. The area had been cleared of trees to increase visibility around the airstrip and at test time contained only surface grasses with scrub oak saplings less than 1 ft high.

43. Terrain units 0-12, 0-14, and 0-16. These units were all originally the same 450-ft terrain unit. Terrain unit 0-12 had a minimum tree spacing of 13.7 ft, but this spacing was increased to 15.2 ft in units 0-14 and 0-16 by removal of some of the smaller trees. The vegetation was composed of large pines and some scrub oaks with a few low shrubs and nearly 100 percent pine straw ground litter.

44. Terrain unit 0-13. This terrain unit was 388 ft long and in an area of nearly 100 percent scrub oak trees with a minimum spacing of 5.3 ft. The trees were so thick that the visibility in the test lane

was only 34 ft. Little or no ground surface vegetation was present on the sandy soil. The test course had a slight upslope of 2.2 percent in the direction of vehicle travel.

45. Terrain unit 0-15. This 365-ft-long terrain unit was in an area east of Airfield 6, which had been logged recently and at test time was overgrown with small oaks. The area was relatively flat with some surface grasses growing with the oaks in the sandy soil (SP). Visibility in the terrain unit was cut to 34 ft by thick saplings.

46. Terrain unit 0-17. This terrain unit, at the western edge of Airfield 6, had been logged just before test time. Only large scrub oaks and unmarketable pines remained in the sandy soil (SP), which was otherwise devoid of vegetation.

Houghton Traverses and Terrain Units

Traverses

47. All three traverses were in the Keweenaw Peninsula of the Upper Peninsula of Michigan, northeast of Houghton-Hancock. Most terrain units of all three traverses were forested areas with characteristic vegetation of the area, including maples, poplars, and pines with scattered low shrubs and blueberry patches growing in loamy sand (SP-SM) with some organic matter in the low areas. The area in general was harshly glaciated with random-rounded and traverse ridges, with abrupt irregular ditches, which, in combination, produced rather high values of surface roughness in most terrain units. (Tests were conducted with some vehicles in the spring and some in the fall of the year. Therefore, descriptions given below relate to both seasonal conditions unless stated otherwise.)

48. Traverse 1. This 4550-ft-long traverse, near the village of Ahmeek, was the most open and level traverse of the three. The initial 2346 ft was relatively bare with mostly lichens, grasses, and blueberry bushes along with scattered currant bushes as vegetable cover. Also, of the remaining 2204 ft, 568 ft was open with only grasses as surface

vegetation. The last 717 ft of the traverse was composed of dense pine and poplar growths, which hindered visibility. The entire profile was relatively irregular with numerous surface irregularities and rocks. Recognition distances were generally about the same in the pine areas in both the spring and fall tests.

49. Traverse 2. West of Traverse 1, this 4050-ft-long traverse was composed of 100 percent heavy vegetation with much deadfall and numerous stumps. The major feature in the surface profile was a deep, scoured area about one third of the way down in the traverse with sloping tree-covered sides of greater than 16 percent slope. The vegetation all along the traverse was closely spaced, with the minimum tree spacing in all units less than 10 ft. Visibility in some of the units was cut to less than 25 ft by the dense vegetation. In the fall, the visibility was much better as a result of leaf loss caused by a seasonal change.

50. Traverse 3. Near the Houghton County Airport, this 3025-ft-long traverse was very rough, with heavy stands of maple trees and numerous large boulders. Only one 500-ft area was open but was covered with surface grasses and scattered currant bushes. The soil was relatively firm in most areas, although the surface was soft and wet in the drainage areas. Minimum tree spacings were, in general, about 10 ft, which created visibility problems by reducing recognition distances to less than 25 ft in most units. This visibility problem was nonexistent during the fall.

Terrain units

51. Terrain unit 0-1. This terrain unit was modified from existing terrain to create a terrain unit with a minimum tree spacing of about 8 ft. The vegetation in the entire 330-ft unit was composed of maple trees of various diameters over rocky, sand soil with some surface roughness. The surface was essentially bare except for lichens and mosses; visibility was not impaired by the vegetation.

52. Terrain unit 0-2. This short 100ft wooded terrain unit was adjacent to terrain unit 0-5 of Traverse 2. The 23.9 percent sloping terrain was heavily wooded with a relatively rough sandy surface. The

dense growths of small sugar maples and ferns and other surface vegetation reduced visibility in the unit to 52 ft.

53. Terrain unit 0-3. Adjacent to terrain unit 0-6 of Traverse 2, this heavily wooded 300-ft unit was so dense that vehicle passage was difficult. The ground surface was rough with scattered small obstacles, and the dense clumps of sugar maples reduced visibility to only 30 ft.

Fort Knox Traverses and Terrain Units

Traverses

54. Both traverses at Fort Knox were within the boundaries of the Fort Knox Military Reservation, south of Louisville, Kentucky. Each traverse was composed of alternately occurring woods and open areas. Soil types in the area traverse 1 were MH (silt with high plasticity) and CL, and in the terrain units of Traverse 2 were ML (silt with slight plasticity) and CL.

55. Traverse 1. This 14,222-ft traverse was in the northwestern part of Fort Knox in an area known as the Salt River floodplain. The entire traverse was relatively flat, though in some areas of low elevation the water table was at or above the ground surface. Consequently, the soil strength in some of the terrain units was relatively low. Terrain conditions prevented traverse layout in one continuous relatively straight-line segment. Accordingly, this traverse started at a fire lane on the eastern edge of the reservation and completed a somewhat rectangular loop clockwise through the terrain, back onto the fire lane, and then down the fire lane to the starting point.

56. Traverse 2. In the south-central portion of the reservation, this 11,750-ft traverse was rather rough and undulating. Numerous drainageways crossed the traverse in the wooded areas, creating problems for some of the vehicles. The open areas, which were heavily trafficked by armored tracked vehicles during training exercises, presented surface roughness problems in some terrains, especially those near the start of

the traverse, which originated in one of the main training areas of the southern part of the reservation.

Terrain units

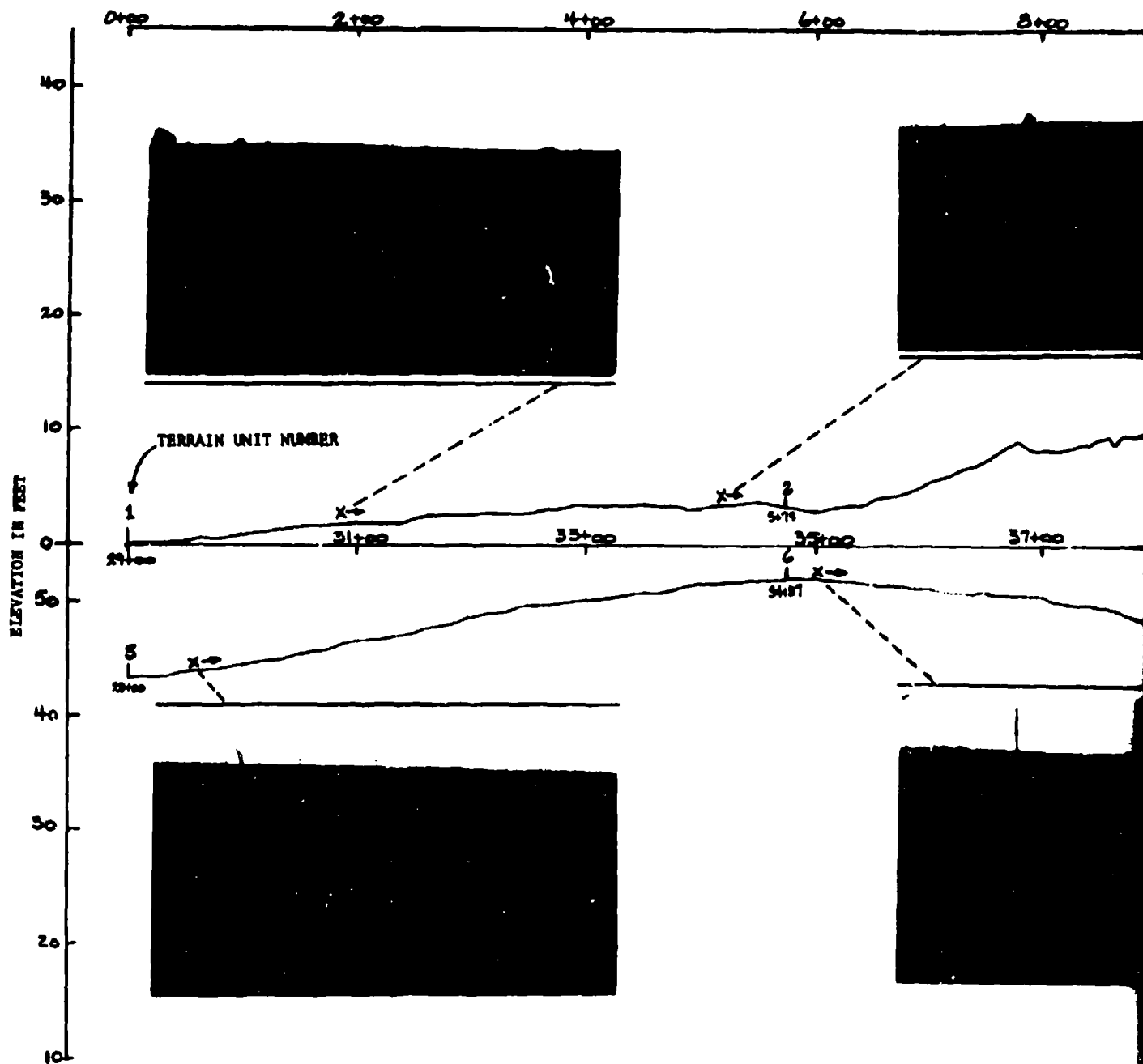
57. Terrain unit 0-1. This 750-ft terrain unit was essentially bare with some small obstacles and some surface roughness. The relatively firm surface was 2.2 percent downslope toward the west.

58. Terrain unit 0-2. This 550-ft unit was nearly 100 percent covered with broom sedge and grasses of various heights, though not tall enough to hinder visibility. The relatively firm surface was downslope 2.1 percent in the same direction as terrain unit 0-1, with only minimal surface roughness and no obstacles.

59. Terrain unit 0-3. This 260-ft unit was modified from existing terrain, by removing some trees, into a uniformly spaced vegetation unit to obtain information on maneuverability of the vehicles. The remaining trees were spaced 20-22 ft apart in an area of thick broom sedge. Visibility was reduced to 55 ft by the grasses. The flat surface was relatively smooth with no obstacles.

60. Terrain unit 0-4. This 400-ft, 7.3 percent grass-covered slope was used to study the effects of slope on vehicle speed. The surface was relatively rough but firm. Surface grasses reduced visibility to 45 ft in the terrain unit.

61. Terrain units 0-5 through 0-10. Near terrain unit 0-3, these six terrain units were actually short linear feature crossings. The units were essentially bare and steep-sided with deformable banks.



A

STATIONS

12+00

14+00

16+00

18+00



X→

41+00

43+00

45+00

47+00

PAVED
ROAD

7

X→

43+20

8

41+20



20+00

22+00

24+00

26+00

28+00

29+00



X →

4

25.75

49+00

51+00

53+00

55+00

57+00



X →

9

10

53.10

53.60

24+00 26+00 28+00 29+00

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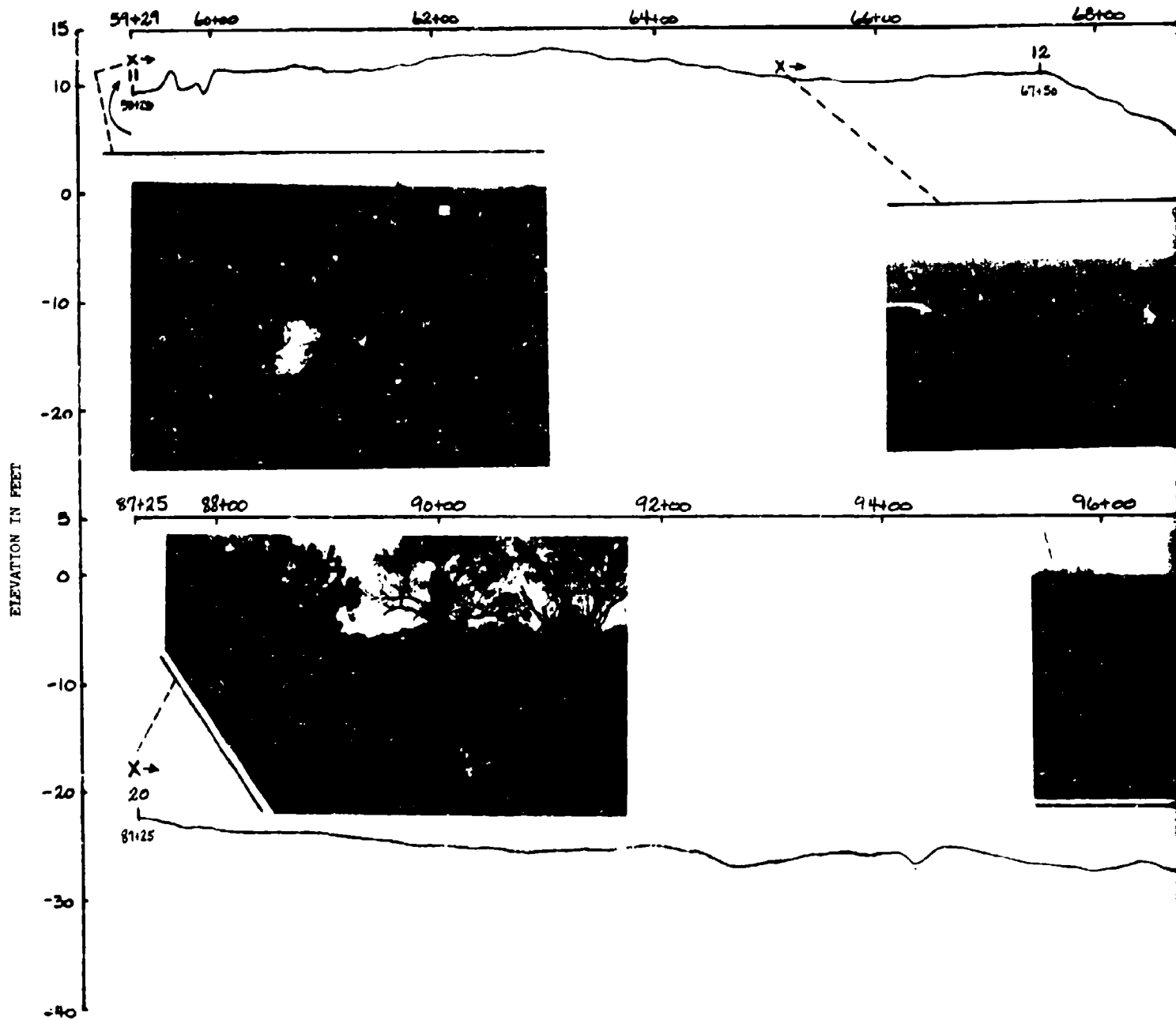
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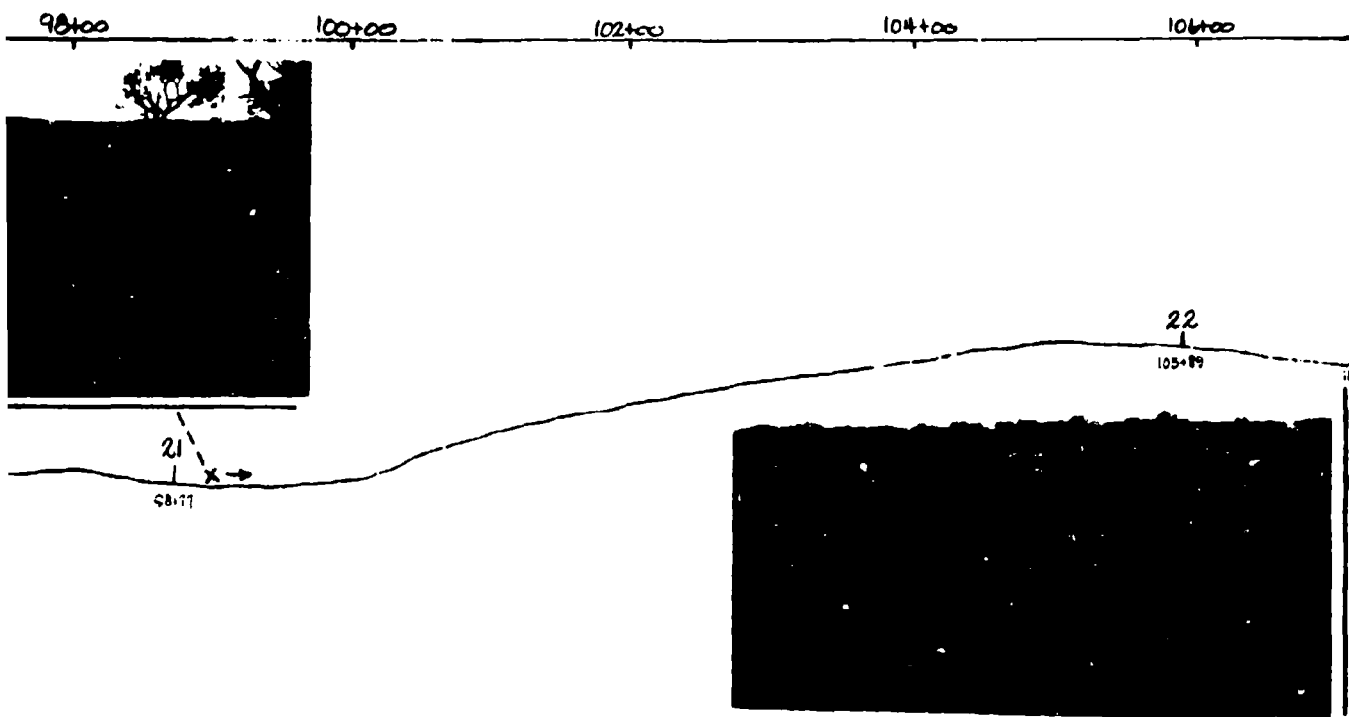
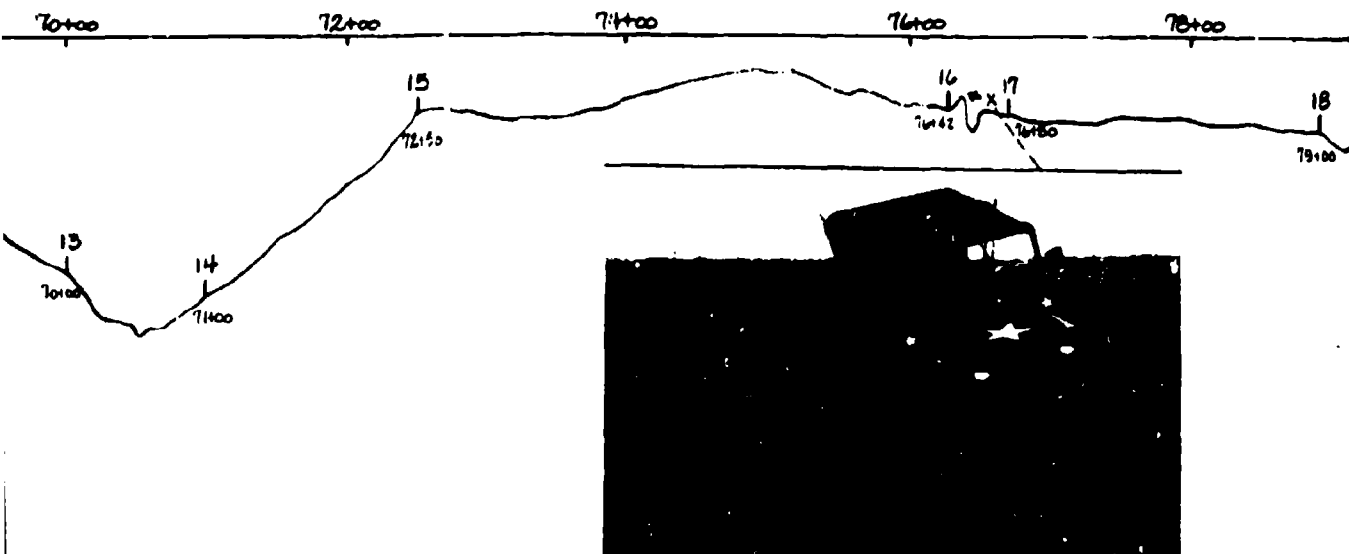
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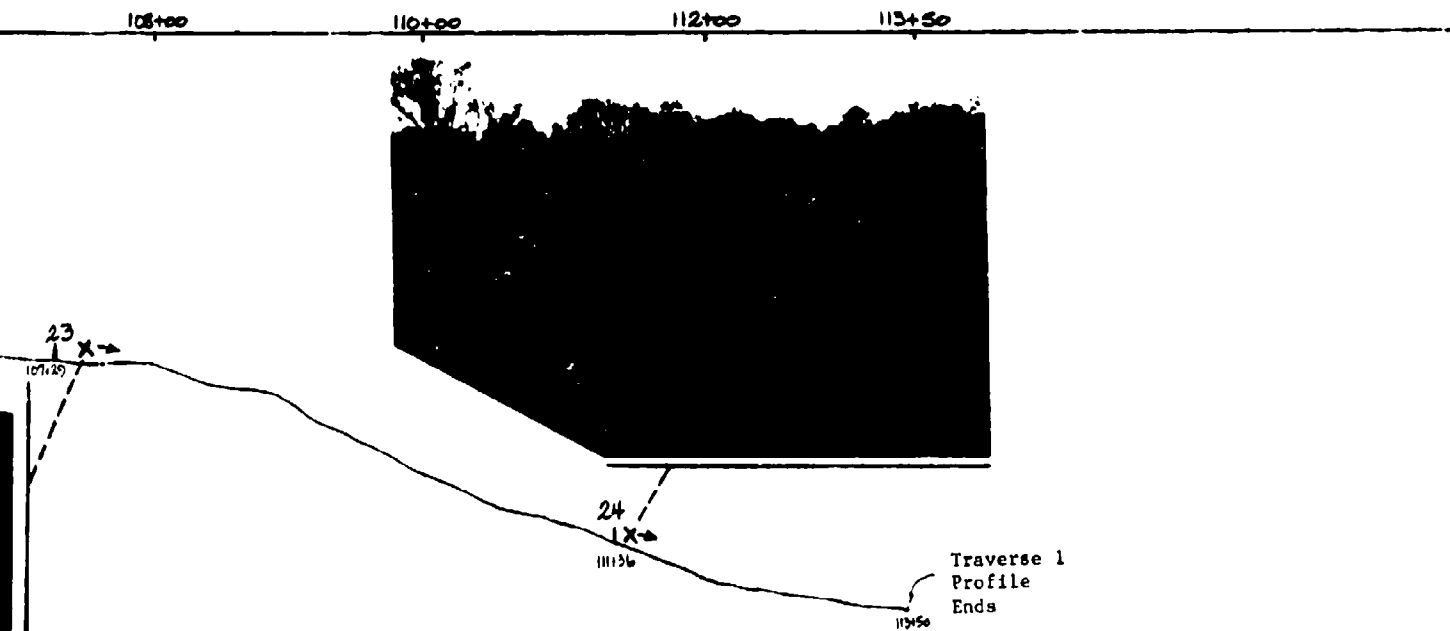
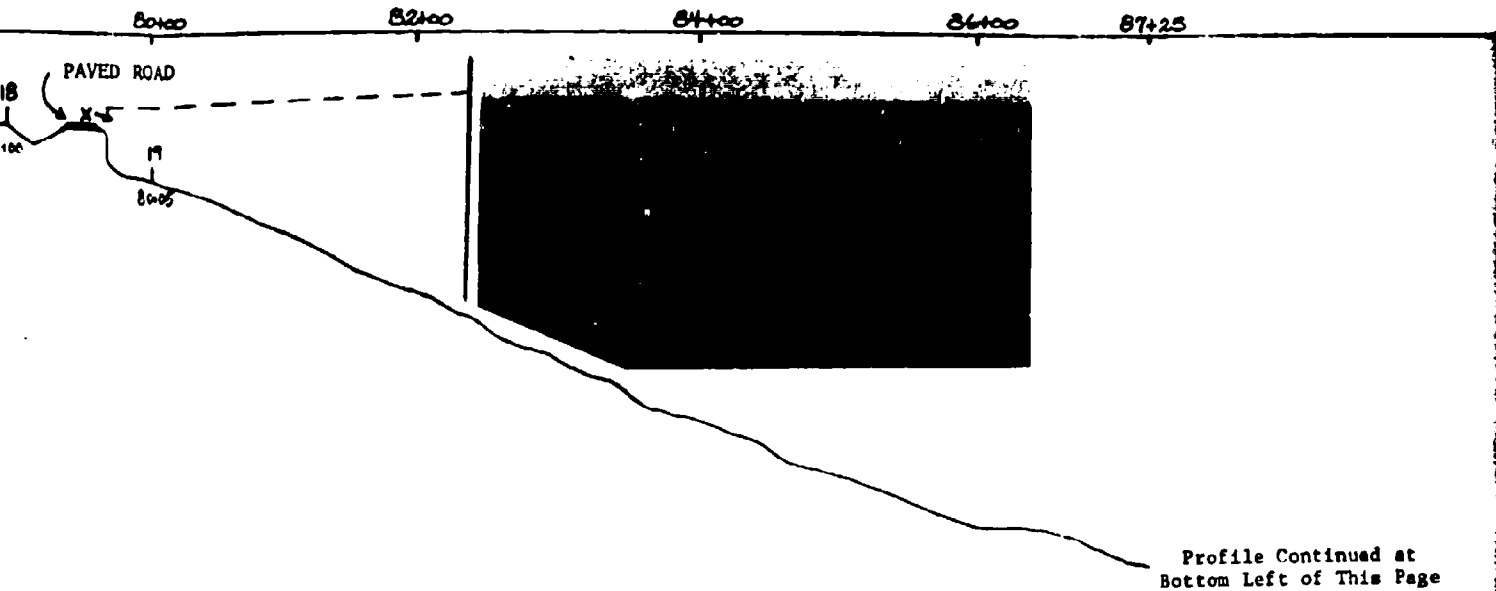
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Page

MOBILITY TEST COURSE
VIEWS AND PROFILES
FORT SILL, OKLA.
TRAVERSE 1



STATIONS





84+00

86+00

87+25

Profile Continued at
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112+00

113+50

24
1X→

111+36

Traverse 1
Profile
Ends

MOBILITY TEST COURSE
VIEWS AND PROFILES
FORT SILL, OKLA.
TRAVERSE 1

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14+00

16+00

18+00

20+00



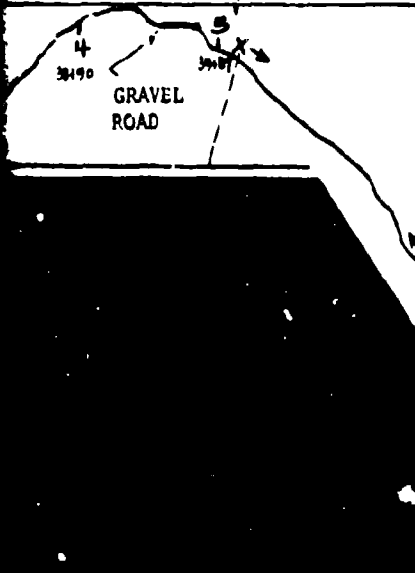
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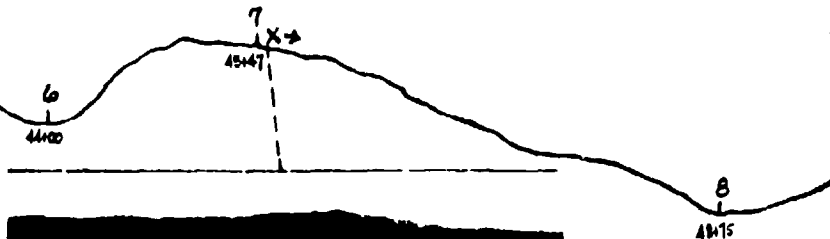
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46+00

48+00



GRAVEL ROAD



8
48+75

20+00

22+00

24+00

26+00

TANK
TRAIL

X→

30+00

32+00

34+00

36+00

36+50

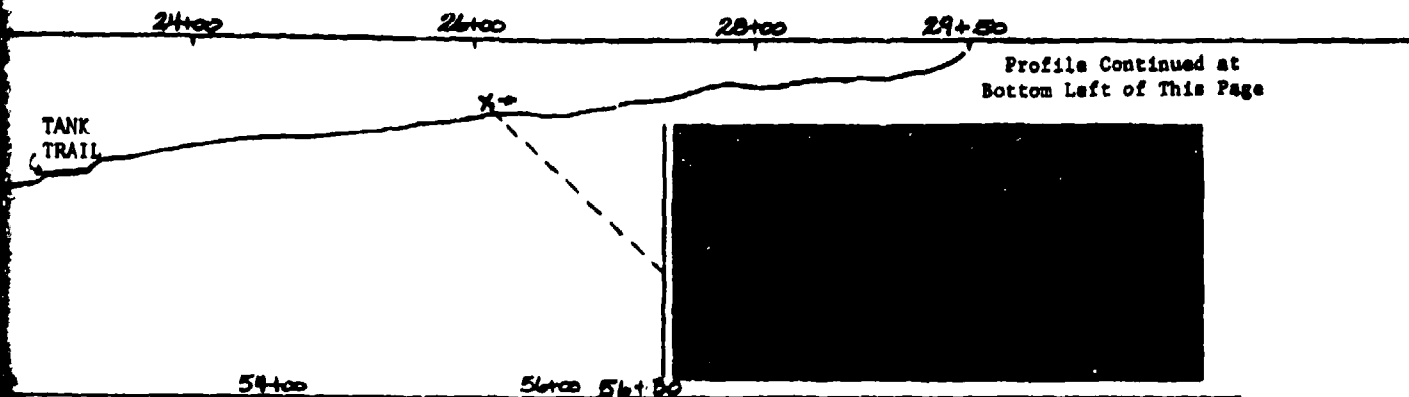


q
51+25

X→

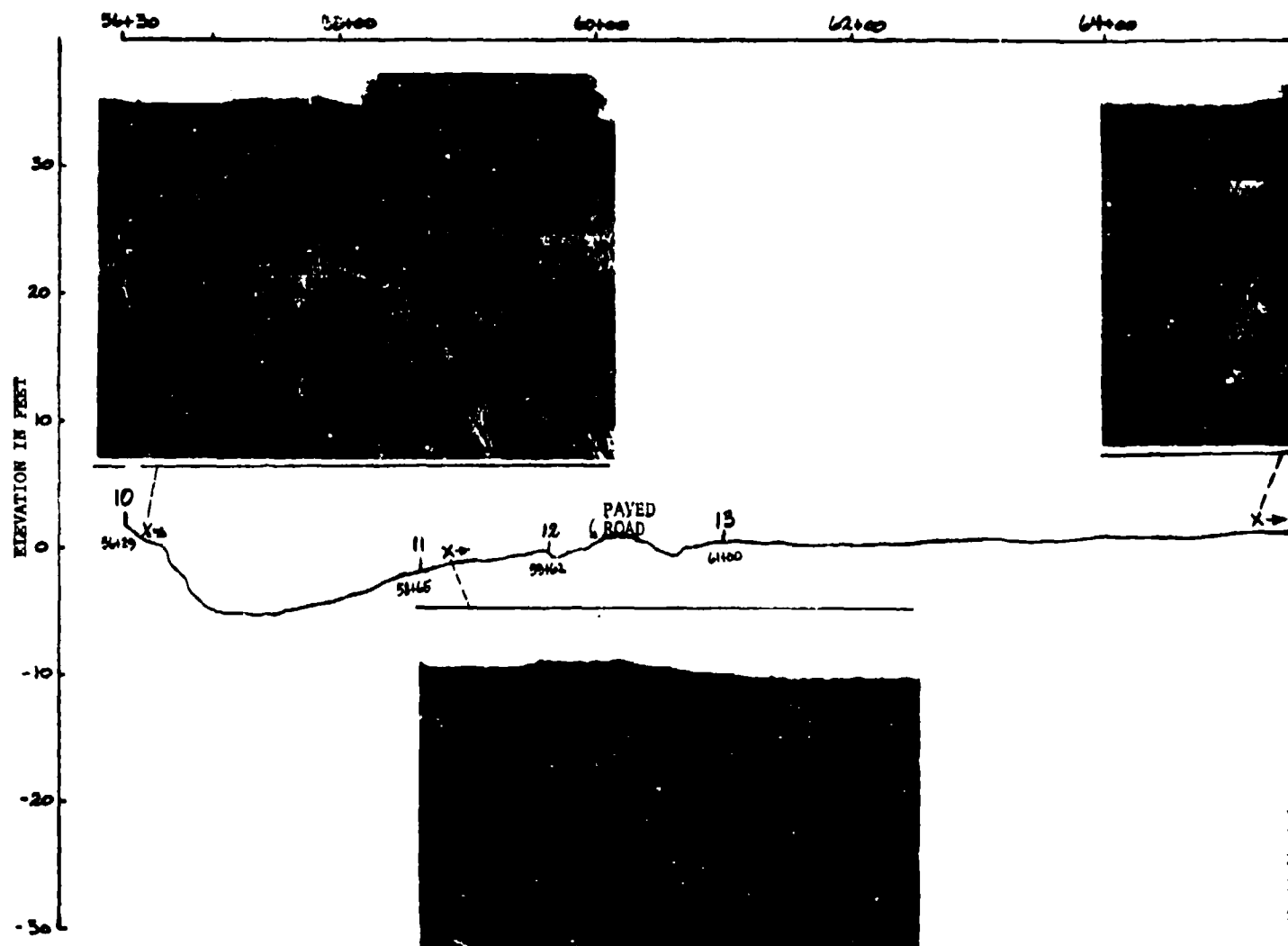
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MOBILITY TEST COURSE
VIEWS AND PROFILES
FORT SILL, OKLA.
TRAVERSE 2



STATIONS

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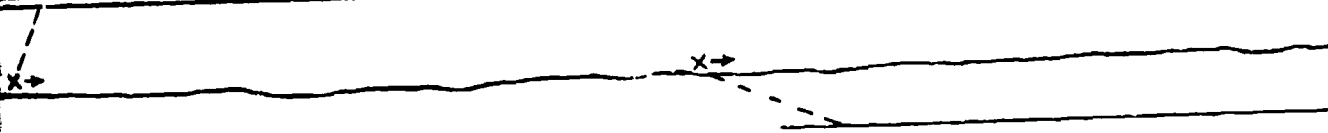
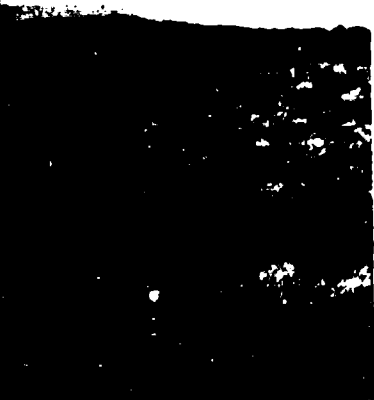
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72+00

74+00

76+00



76+00

78+00

80+00

81+50

Traverse 2
Profile
Ends

81+50

MOBILITY
VIEWS AND
FORT
TRAIL

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PLATE B2 (S)

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80+00

90+00

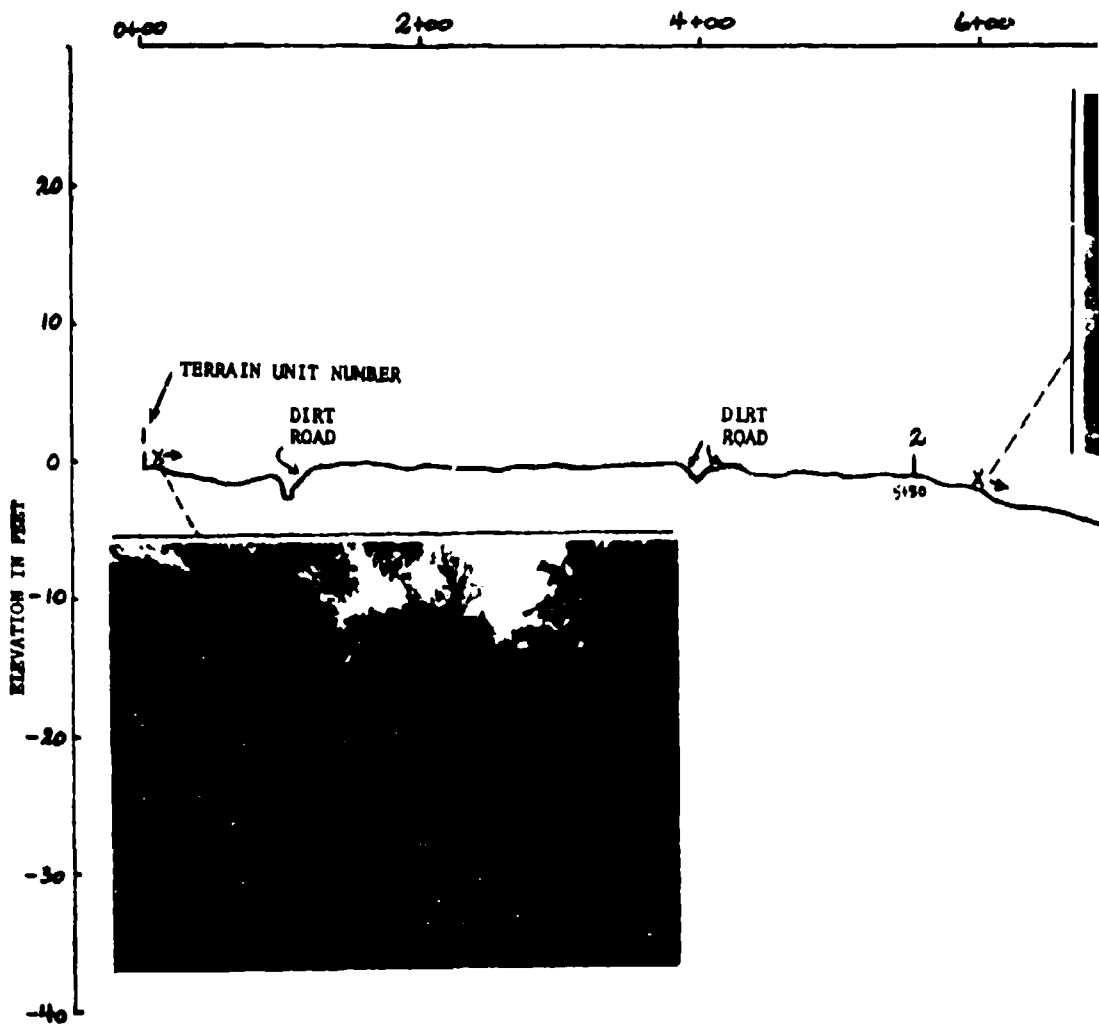
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Profile
Ends

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MOBILITY TEST COURSE
VIEWS AND PROFILES
FORT SILL, OKLA.
TRAVERSE 2

23<

PLATE B2 (Sheet 2 of 2)



A

STATIONS

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14+00

16+00

18+00

10+96

3

X→

4

12+00

5

14+50

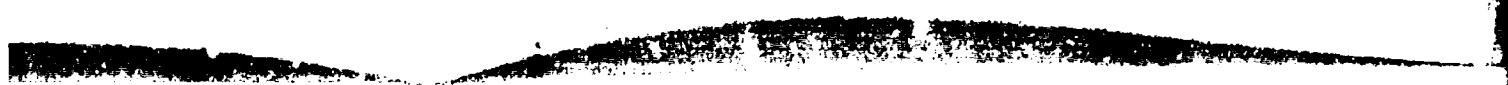
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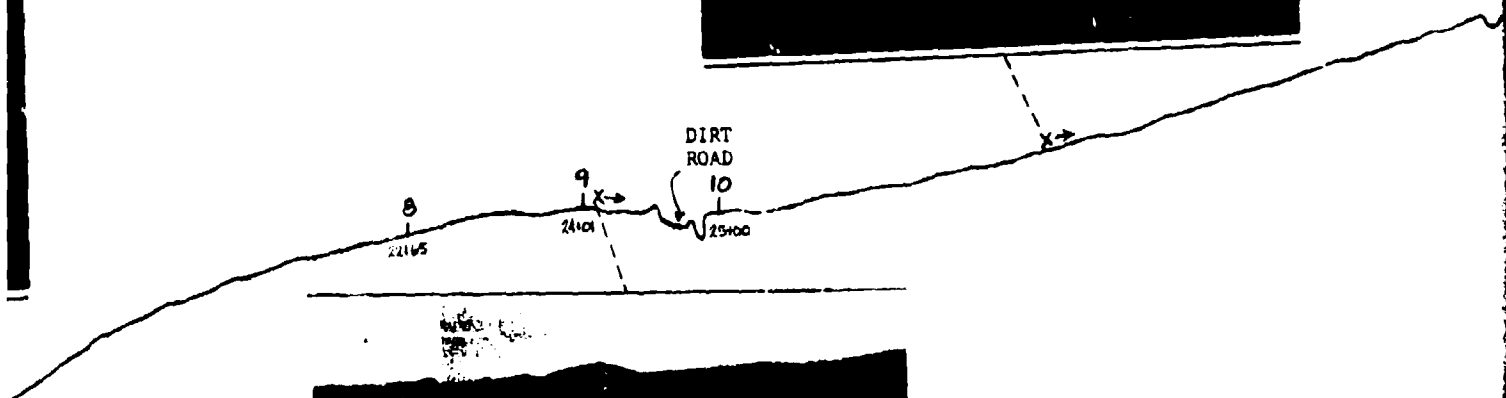
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22+65

9
24+01

DIRT
ROAD
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25+00



30+00

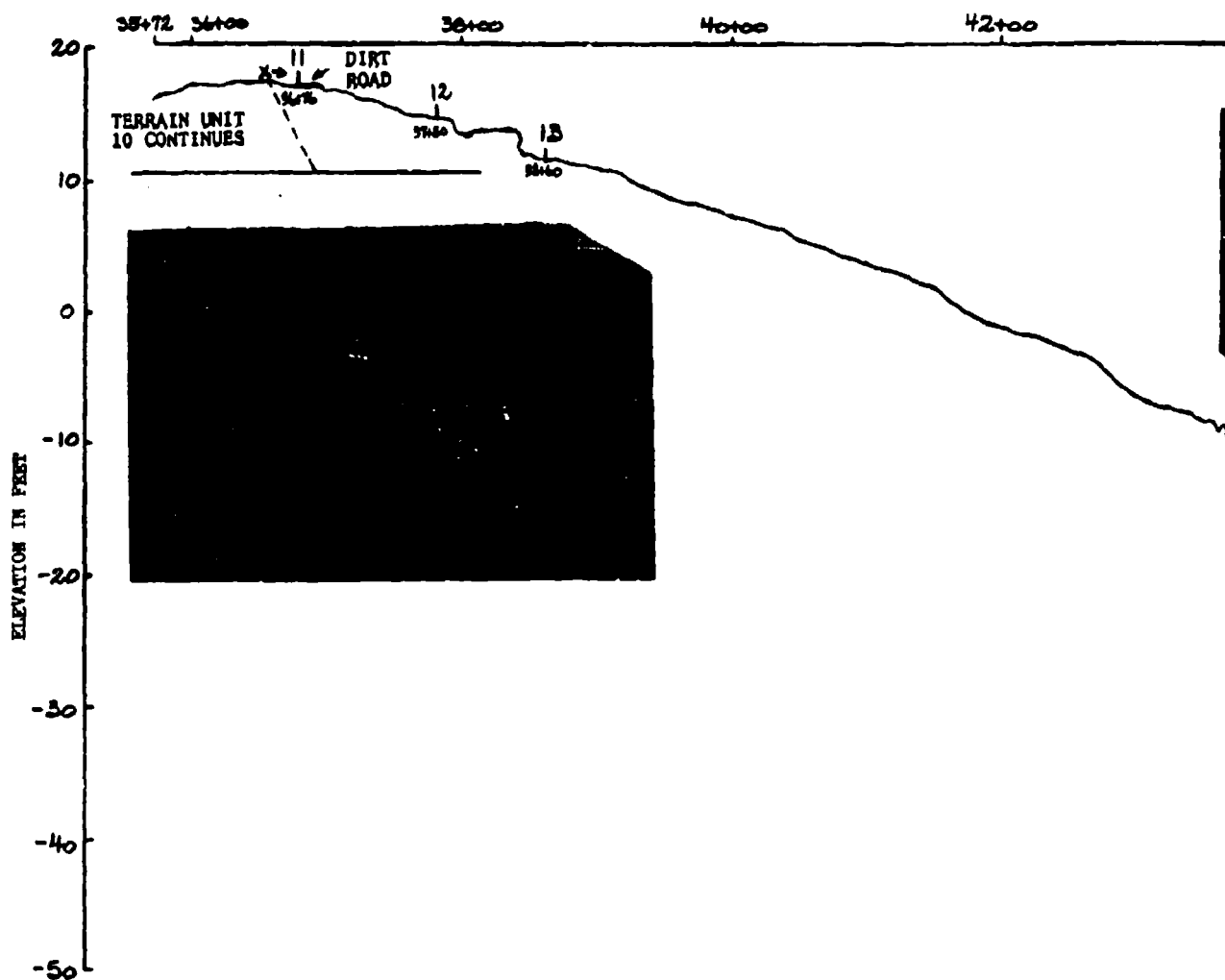
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34+00

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Profile Continues
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MOBILITY TEST COURSE
VIEWS AND PROFILES
FORT SIL., OKLA.
TRAVERSE 3



STATIONS

46+00

48+00

50+00

52+00

54+00

14
46+15

15 GRAVEL ROAD
46+35 16
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17
52+50

GRAVEL ROAD
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54+70

56+00

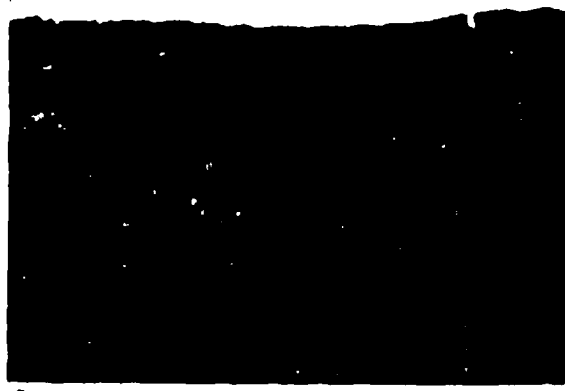
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62+00

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66+00



20
X
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PAVED
ROAD

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67+50

20

PAVED
ROAD

21

63+70

67+50

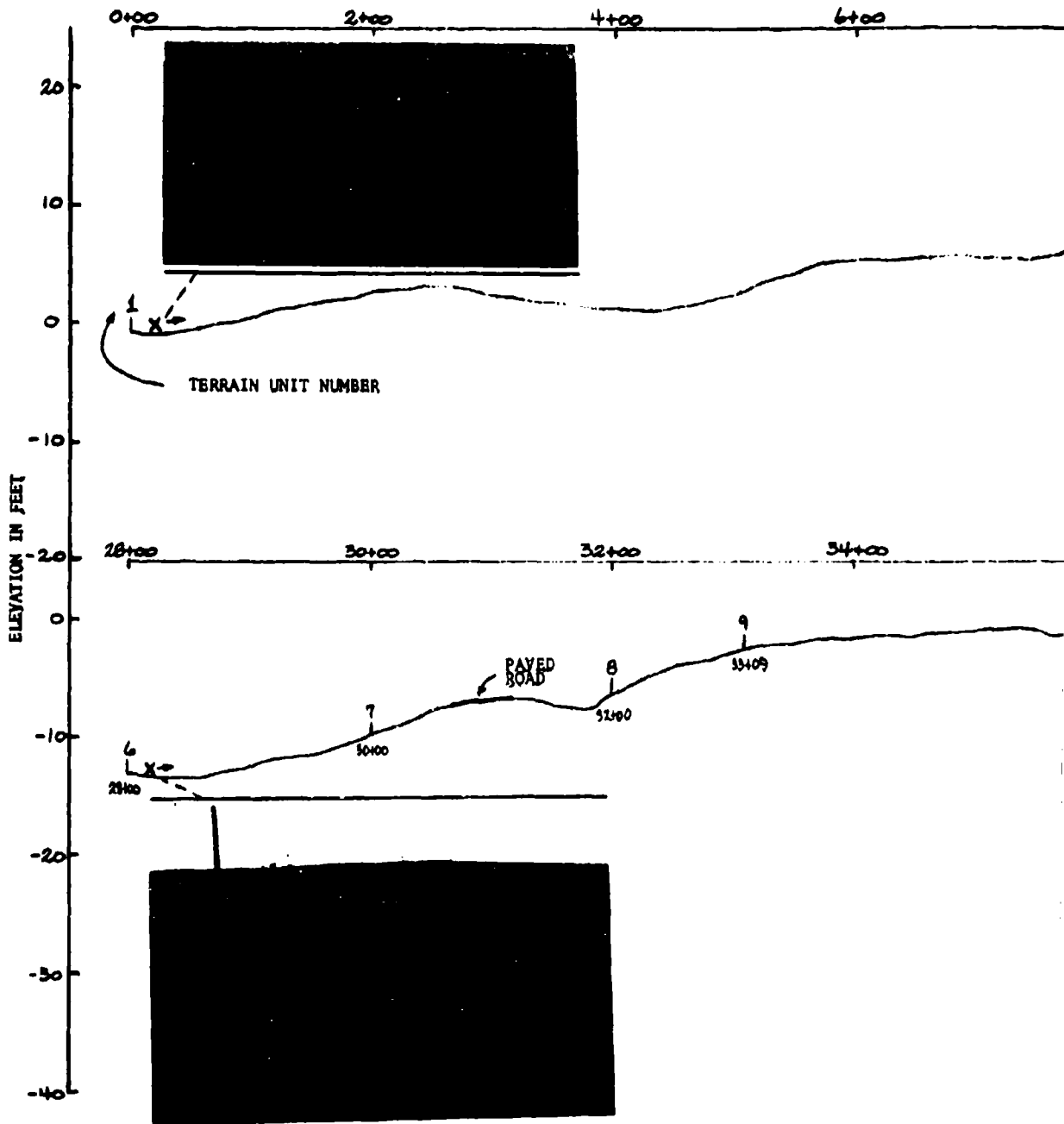
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MOBILITY TEST COURSE
VIEWS AND PROFILES
FORT SILL, OKLA.
TRAVERSE 3

25<

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PLATE B3 (Sheet 2 of 2)



STATIONS

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14+00

16+00

18+00

3

12+00

4

16+00

X→

38+00

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42+00

44+00

46+00

X→

10

42+00

X→

11

46+00

12

48+00

20+00

22+00

24+00

26+00

28+00

5

22+00

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48+00

50+00

52+00

53+00

Traverse 4
Profile
Ends

13

50+38

53+00

12

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52+00

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Traverse 4
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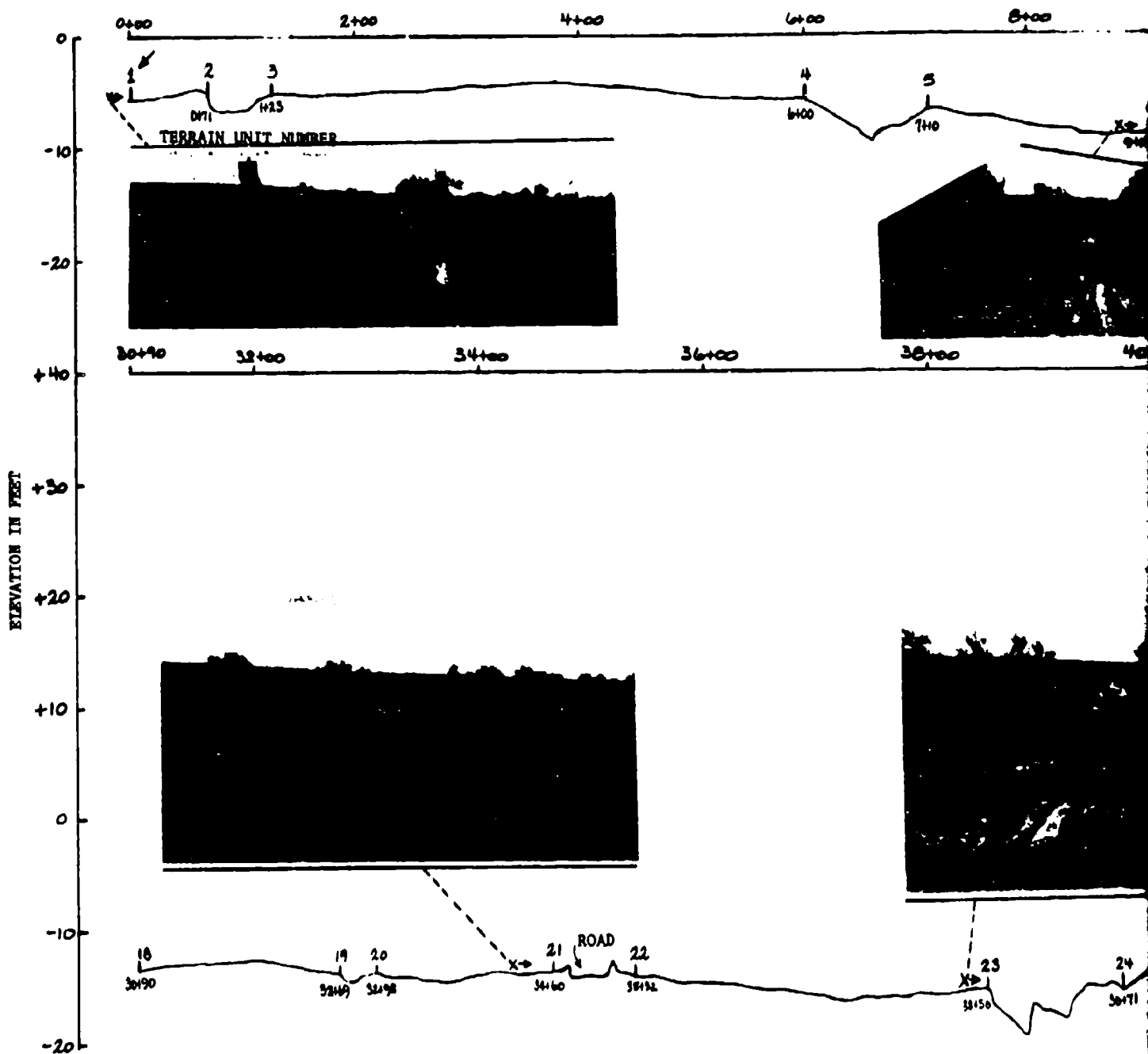
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MOBILITY TEST COURSE
VIEWS AND PROFILES
FORT SILL, OKLA.
TRAVERSE 4

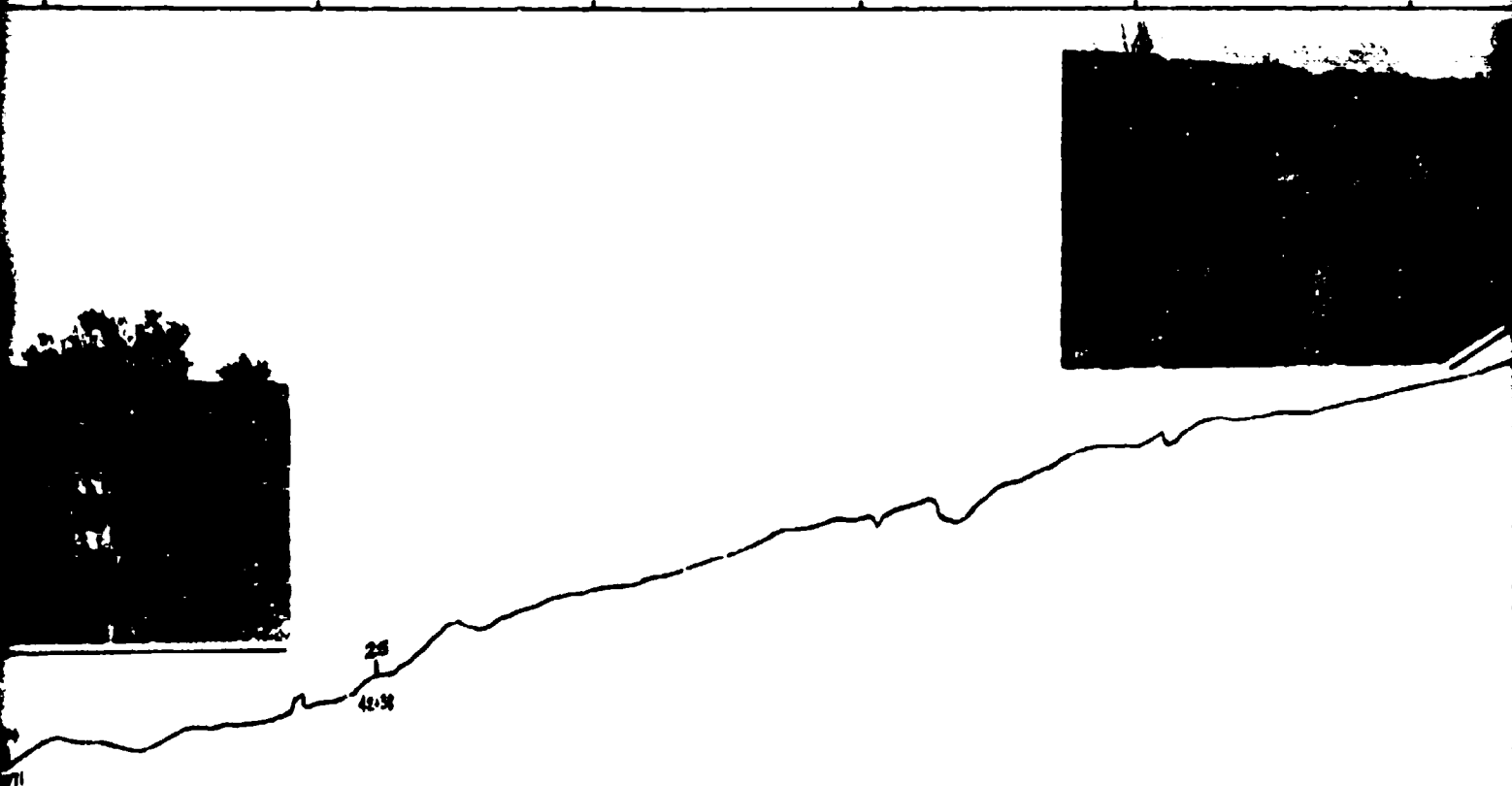
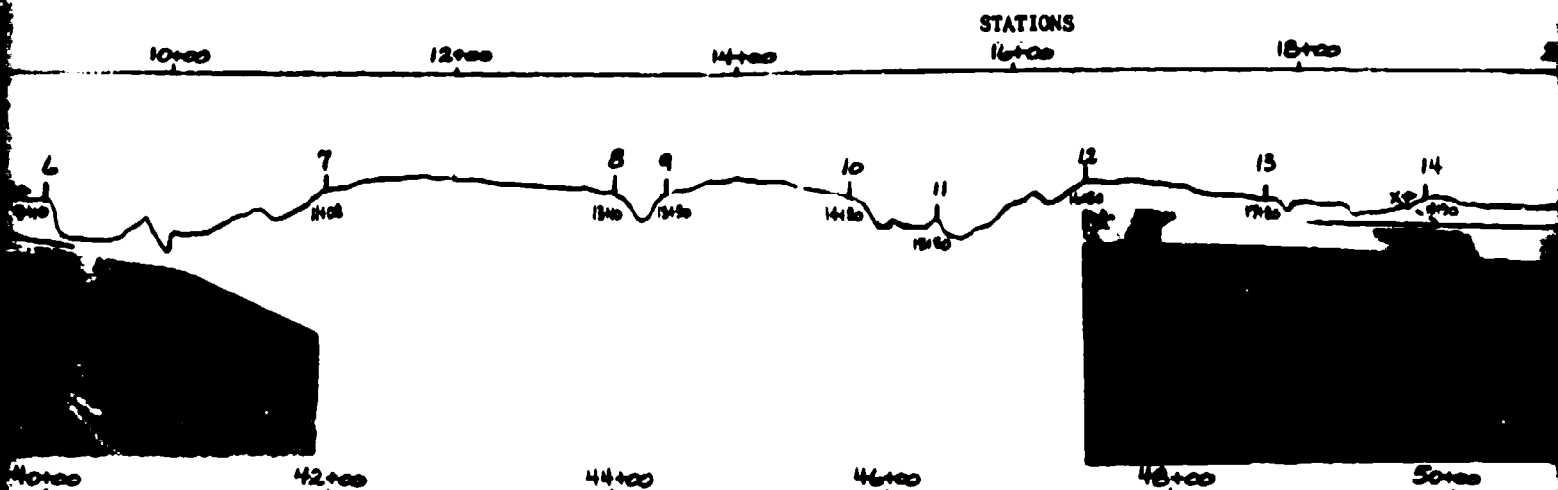
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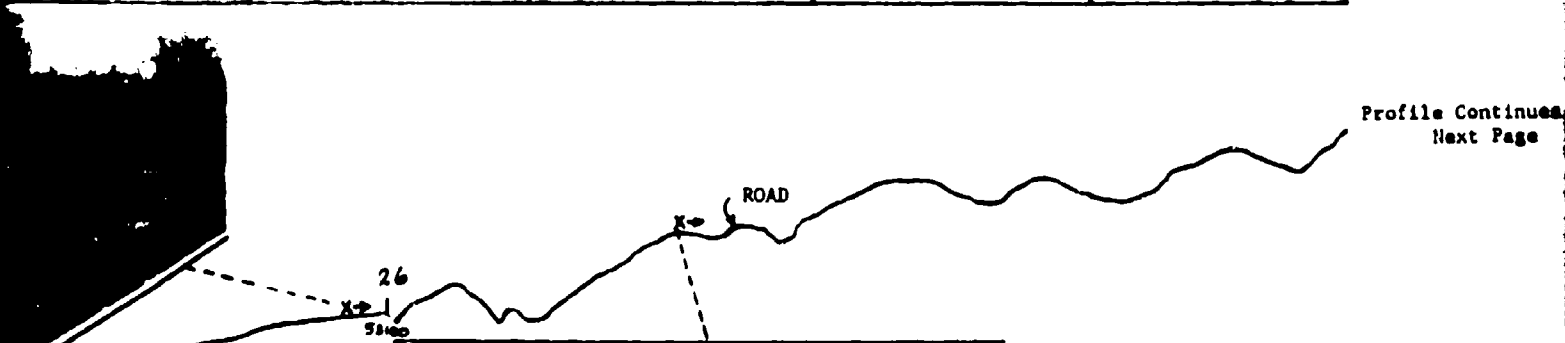
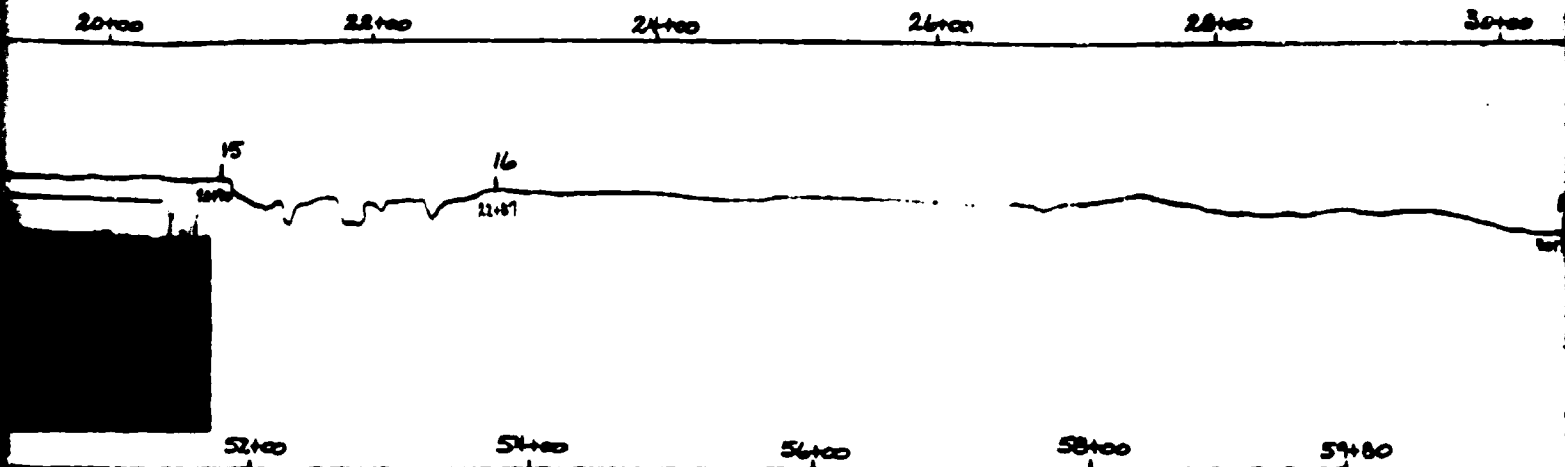
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PLATE B4



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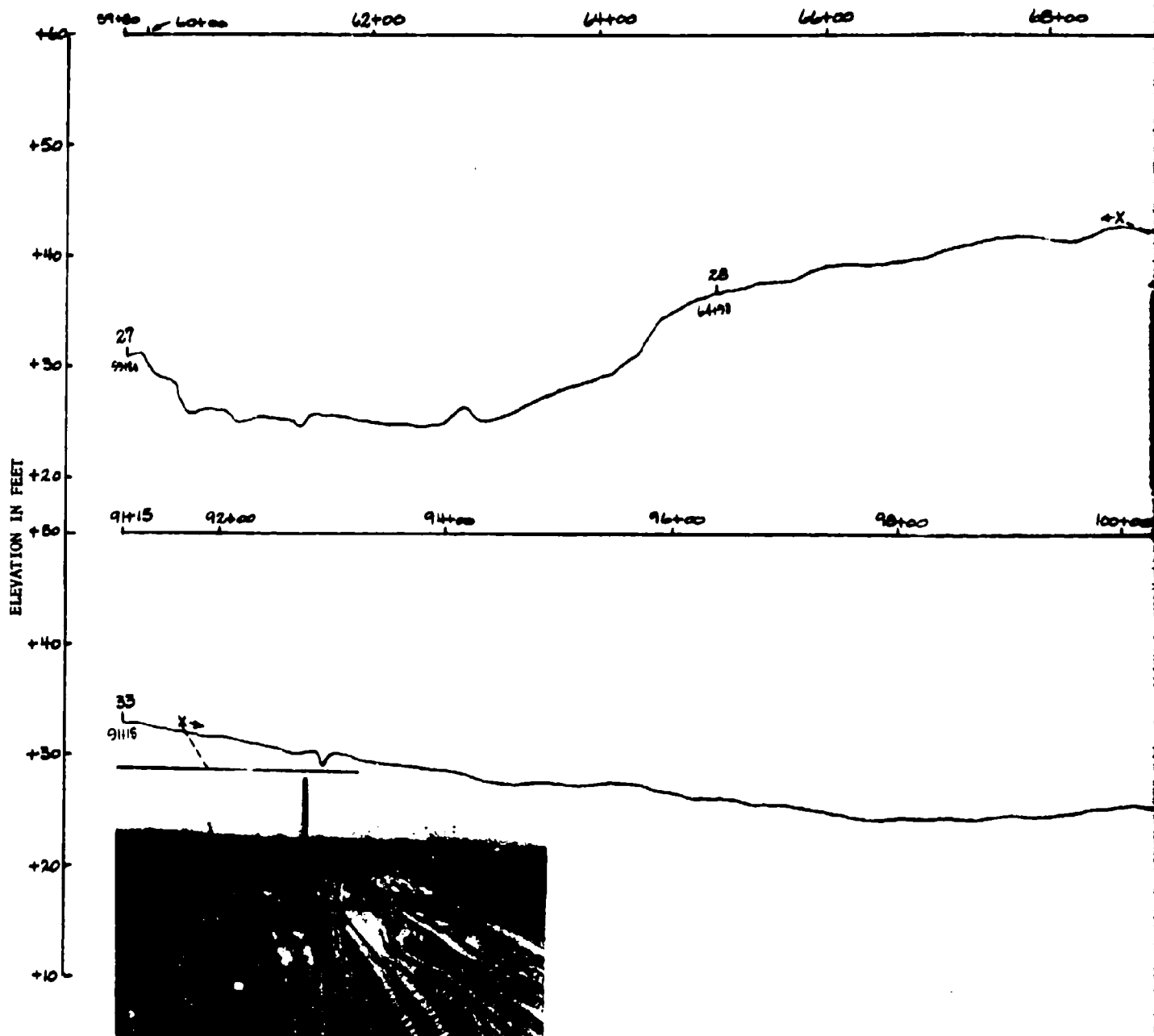
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ROAD

MOBILITY TEST COURSE
VIEWS AND PROFILES
YUMA, ARIZ.
TRAVERSE 1





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74+00

STATIONS

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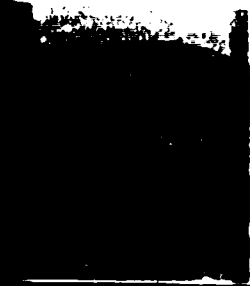
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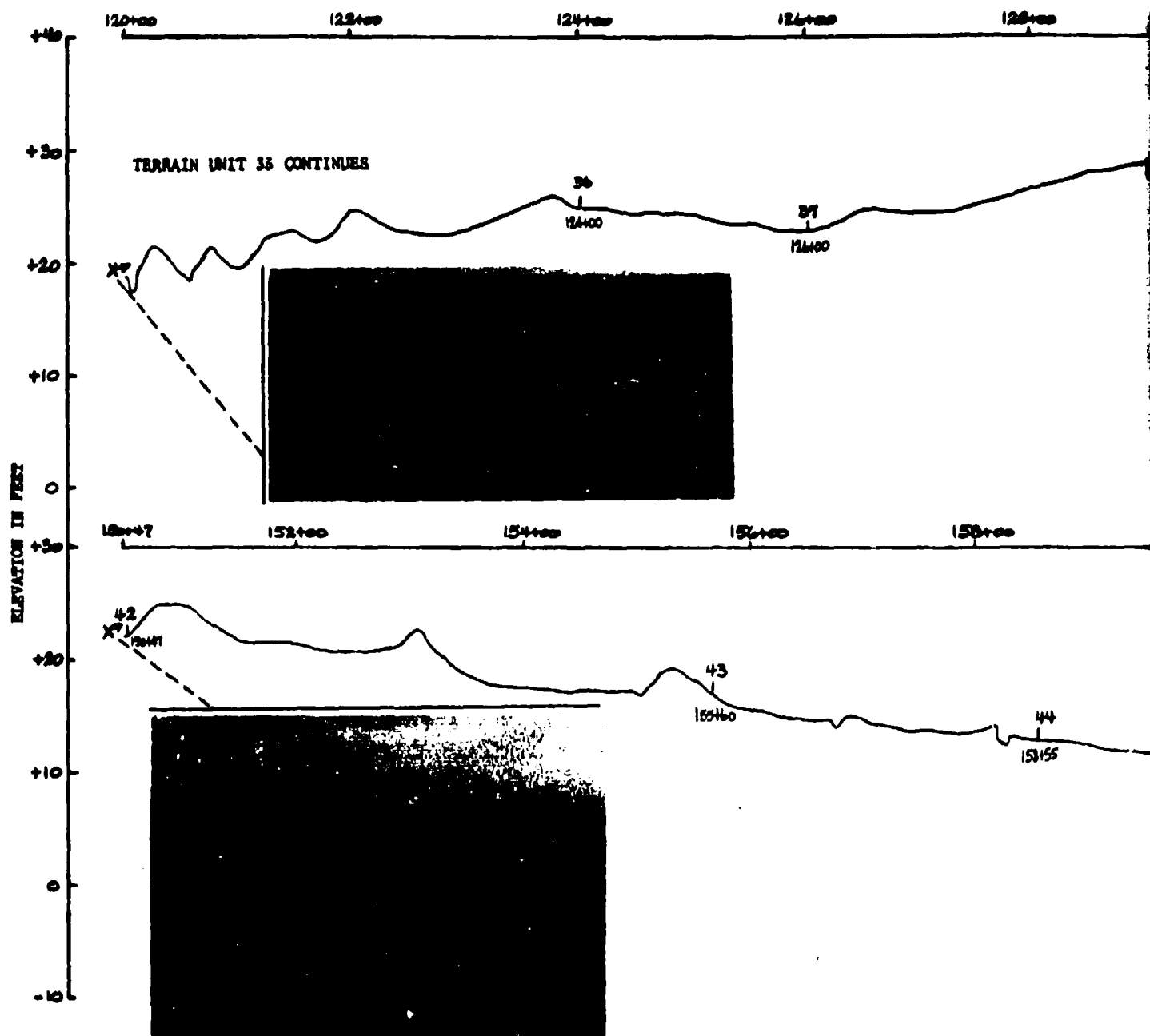
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MOBILITY TEST COURSE
VIEWS AND PROFILES
YUMA, ARIZ.
TRAVERSE 1



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STATIONS
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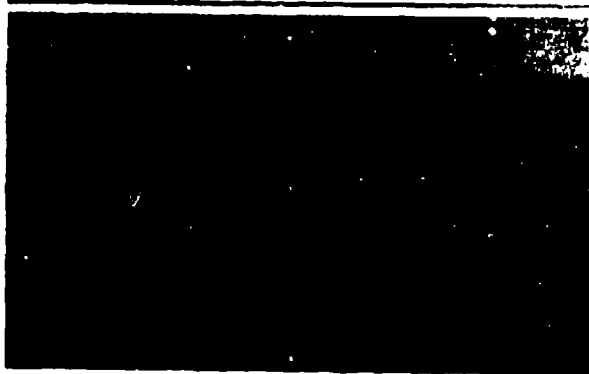
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ROAD 99

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161+45

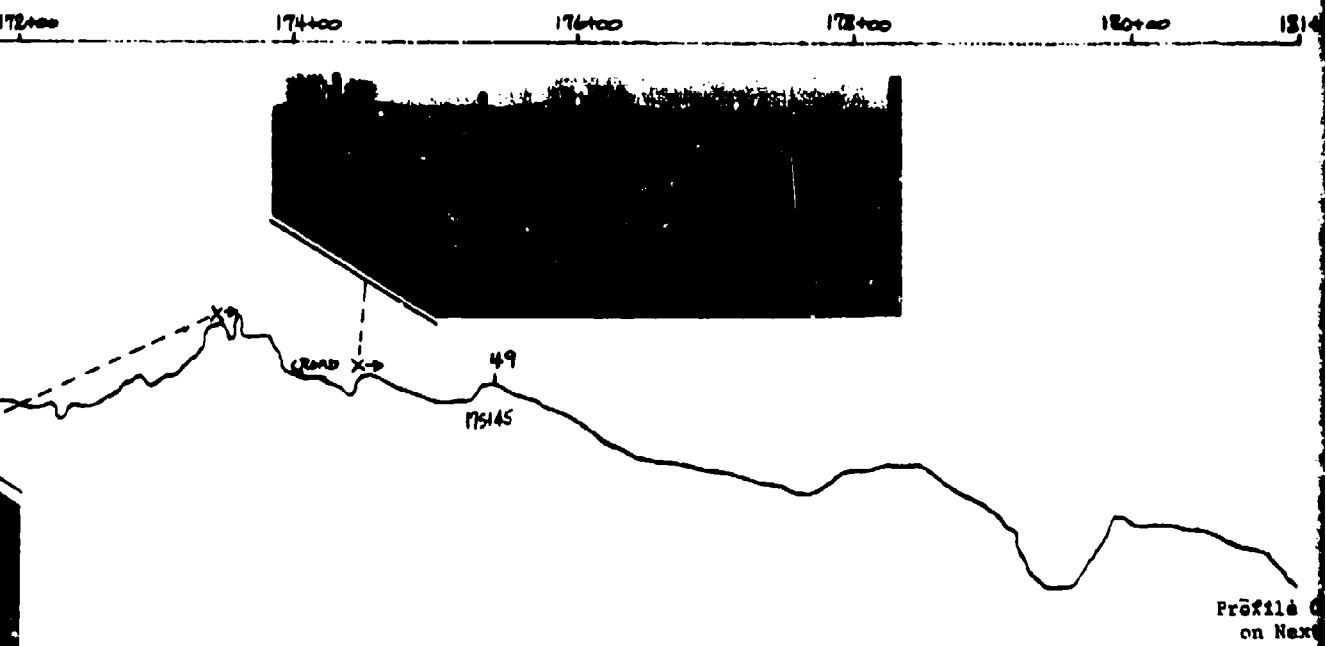
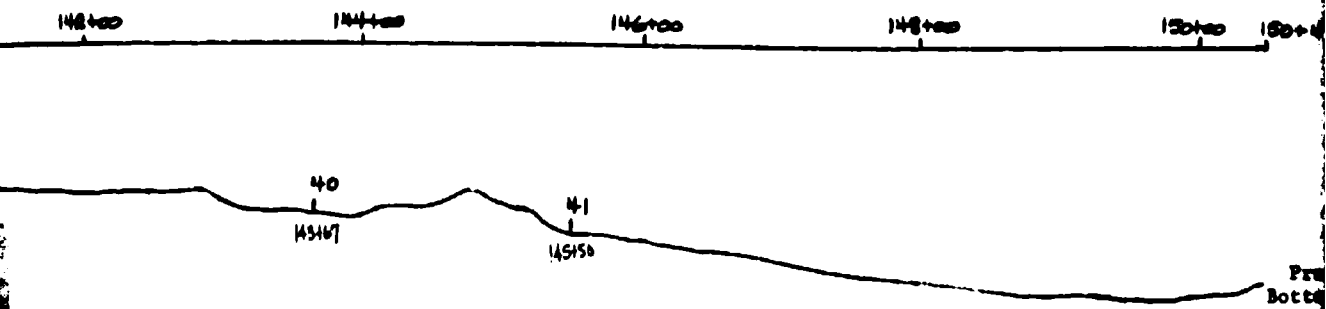
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164+20





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178+00

180+00

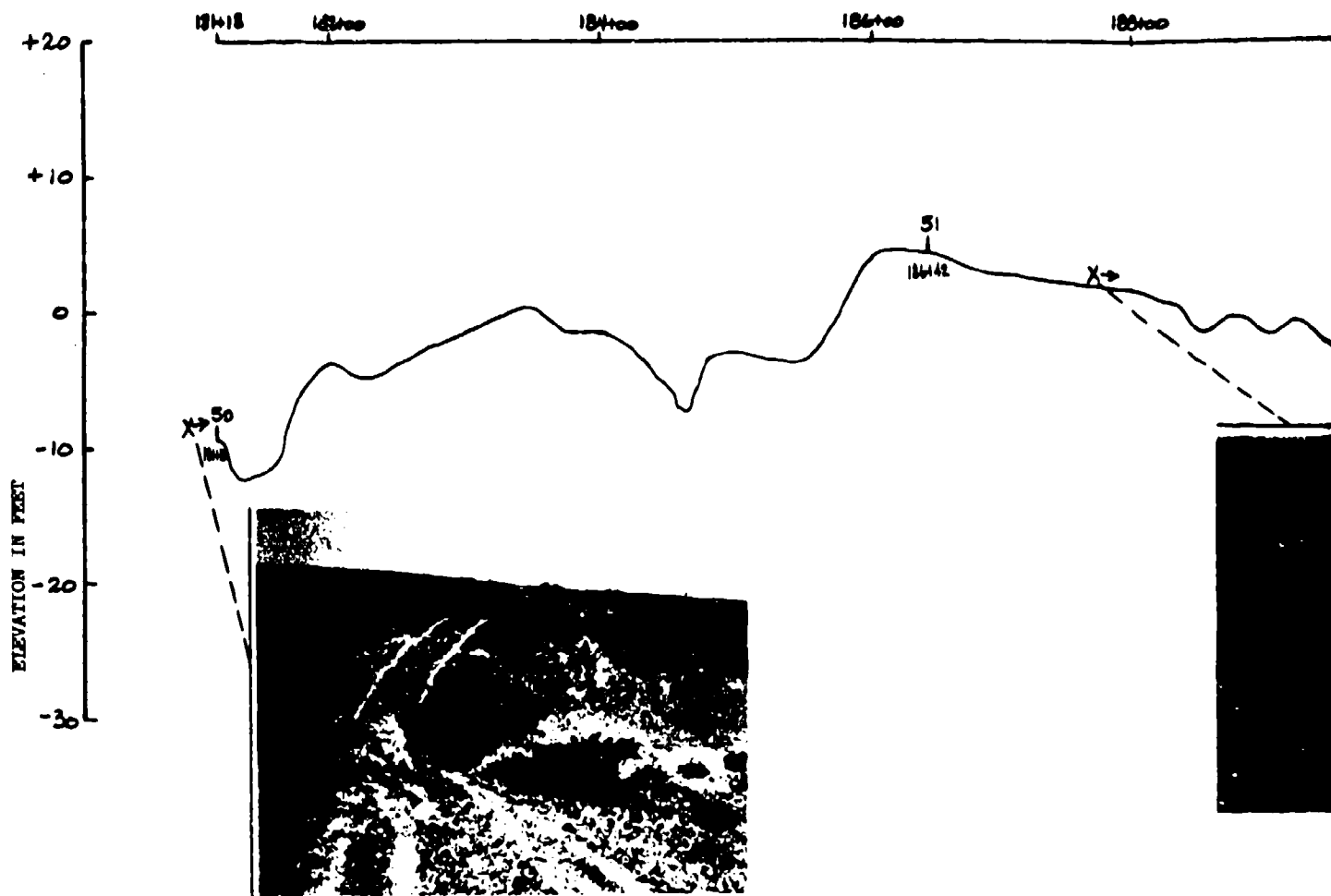
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Profile Continues
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MOBILITY TEST COURSE
VIEWS AND PROFILES
YUMA, ARIZ.
TRAVERSE 1



STATIONS

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192+00

194+00

196+00

198+00

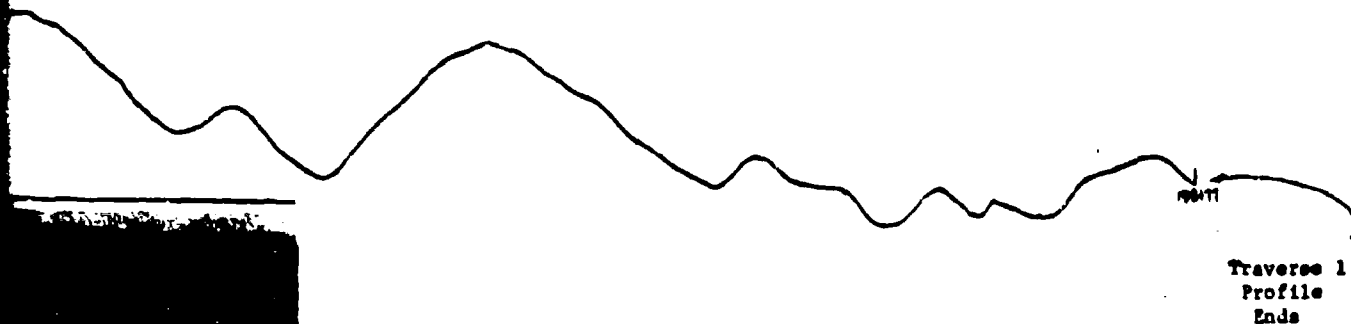
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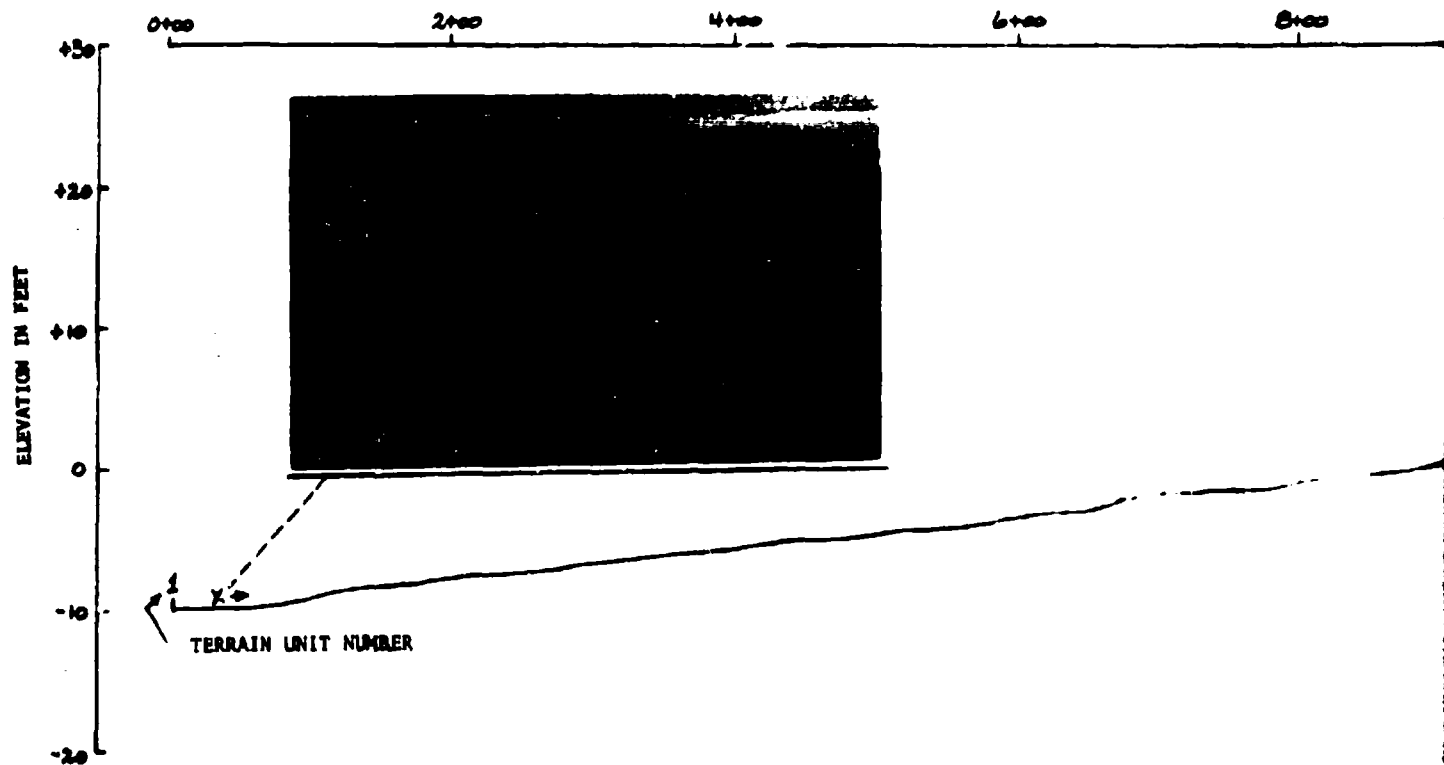
TRAVEL
PROF.
END

MOBILITY TEST COURSE
VIEWS AND PROFILES
YUMA, ARIZ.
TRAVERSE 1

148-77



MOBILITY TEST COURSE
VIEWS AND PROFILES
YUMA, ARIZ.
TRAVERSE 1



14

STATIONS

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12+00

14+00

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2

16135

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Traverse 2

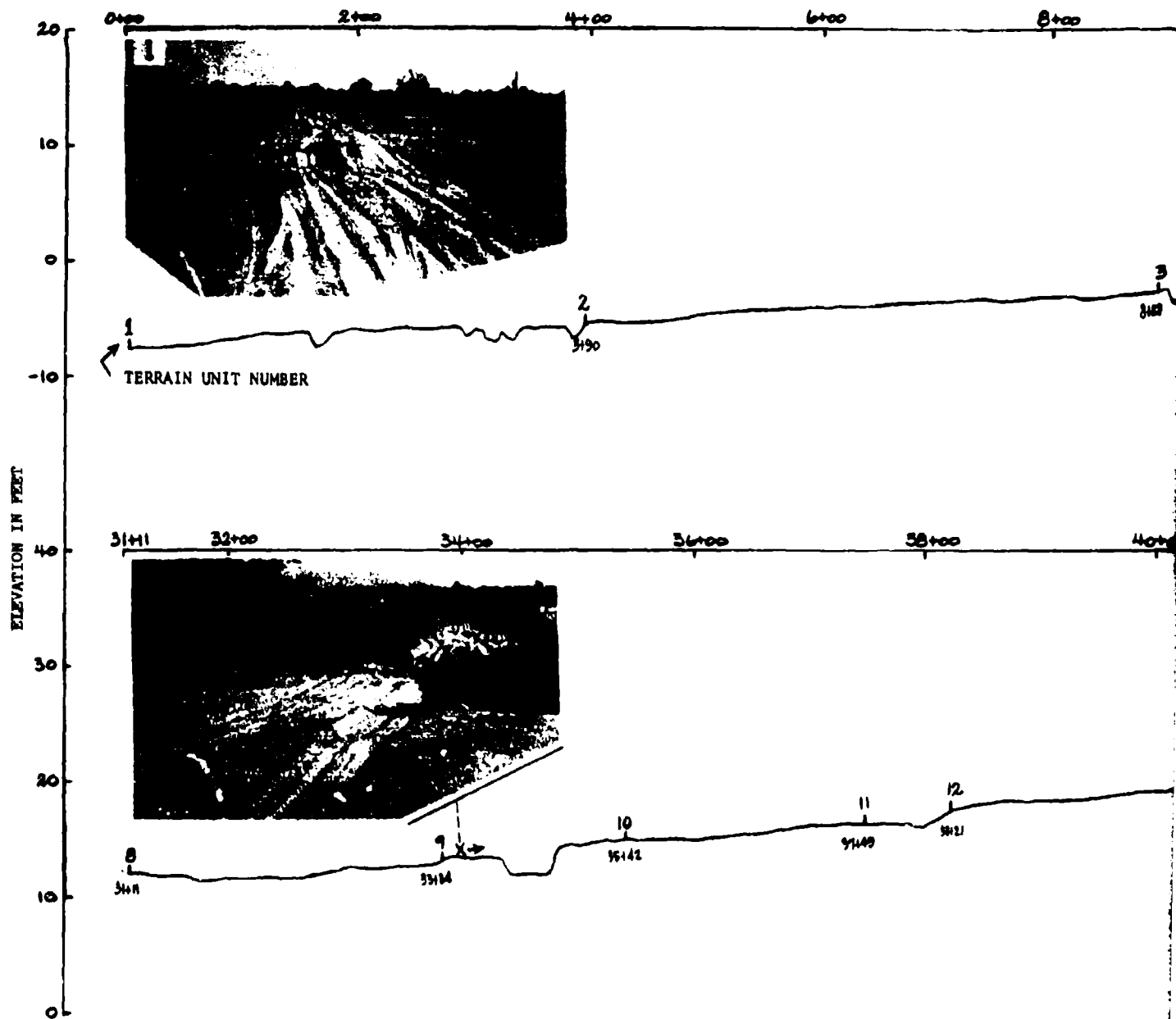
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29102

MOBILITY TEST COURSE
VIEWS AND PROFILES
YUMA, ARIZ.
TRAVERSE 2



H

STATIONS

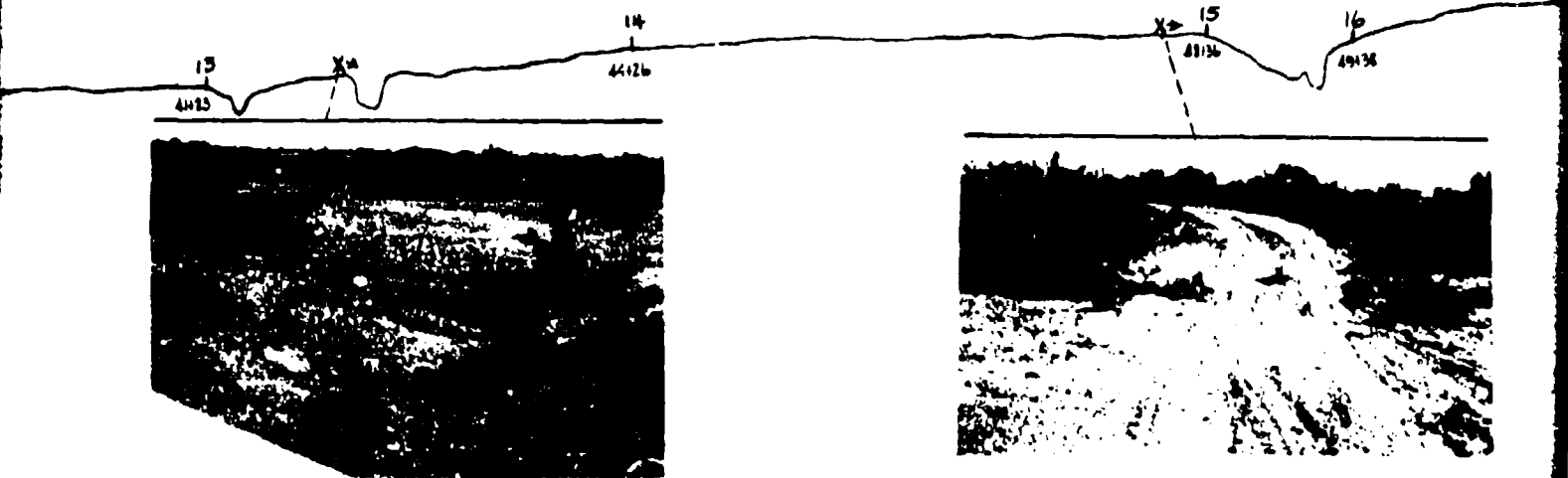
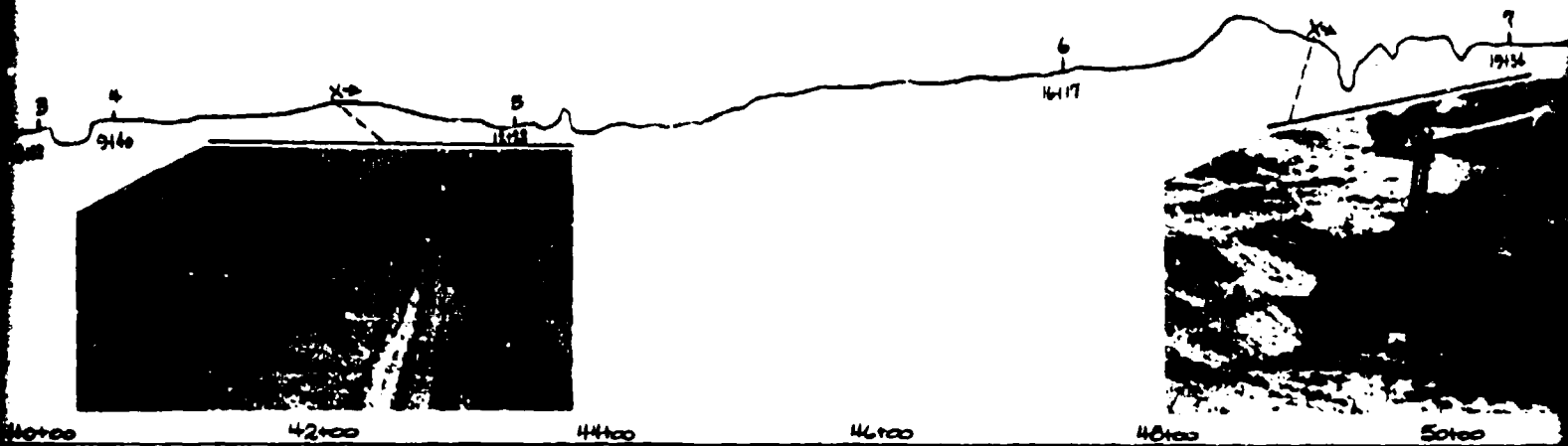
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16+00

18+00



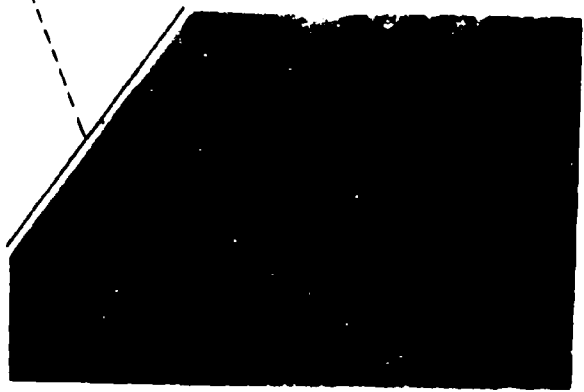
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52+00 54+00 56+00 58+00 59+80



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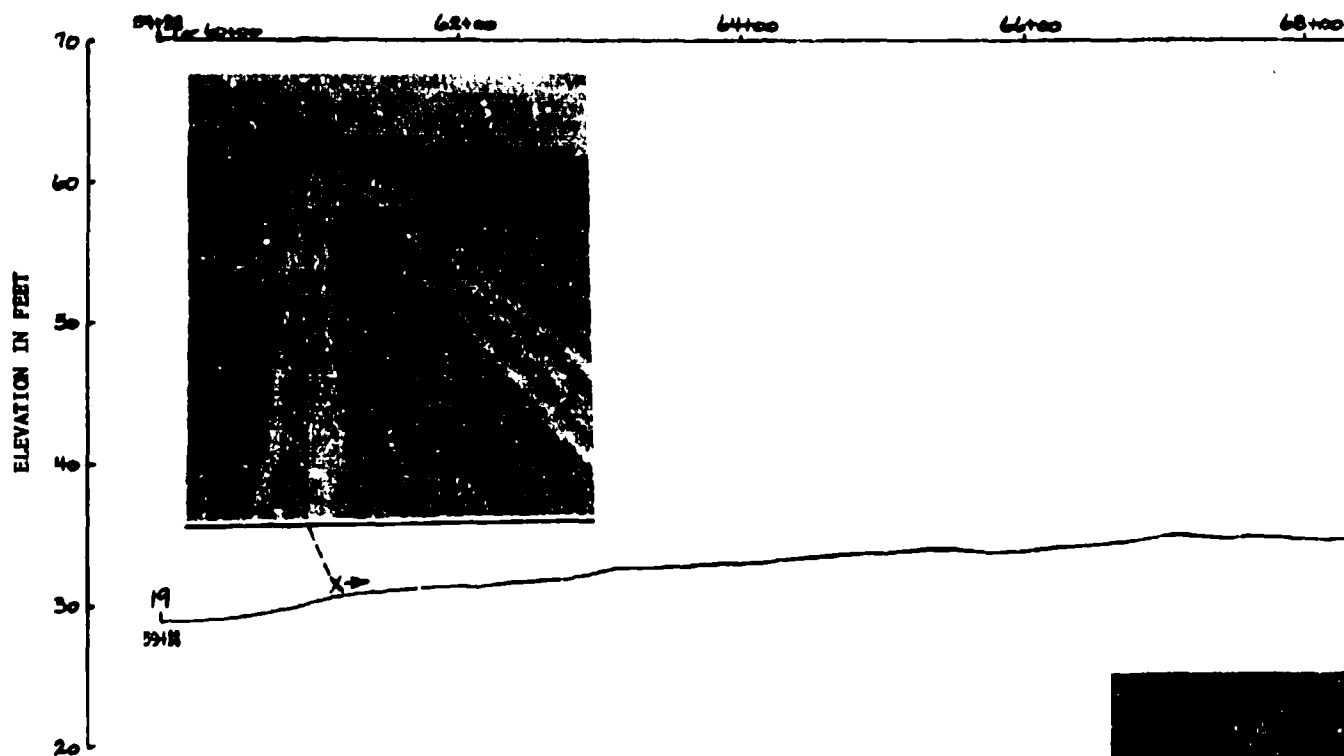
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56+00 58+00 59+00

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MOBILITY TEST COURSE
VIEWS AND PROFILES
YUMA, ARIZ.
TRAVERSE 3

D



I

STATIONS

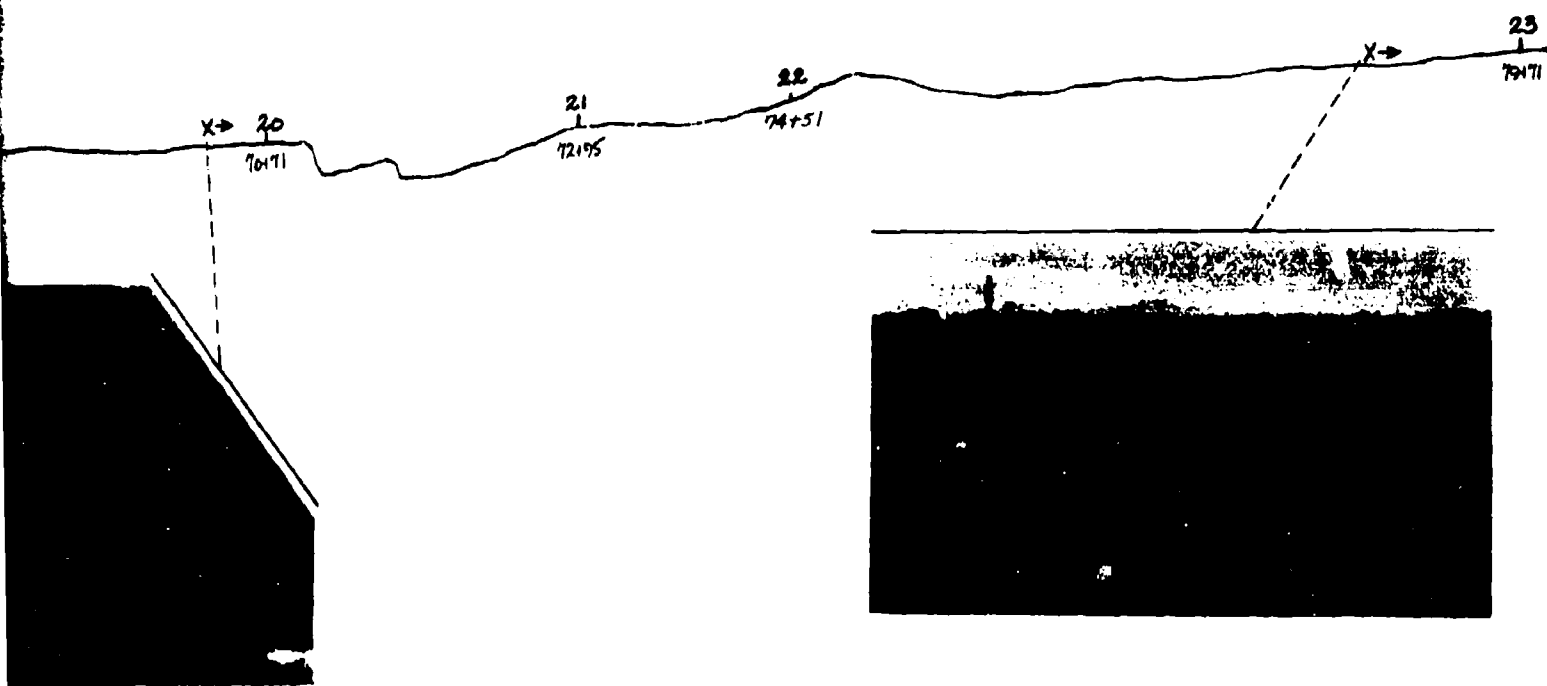
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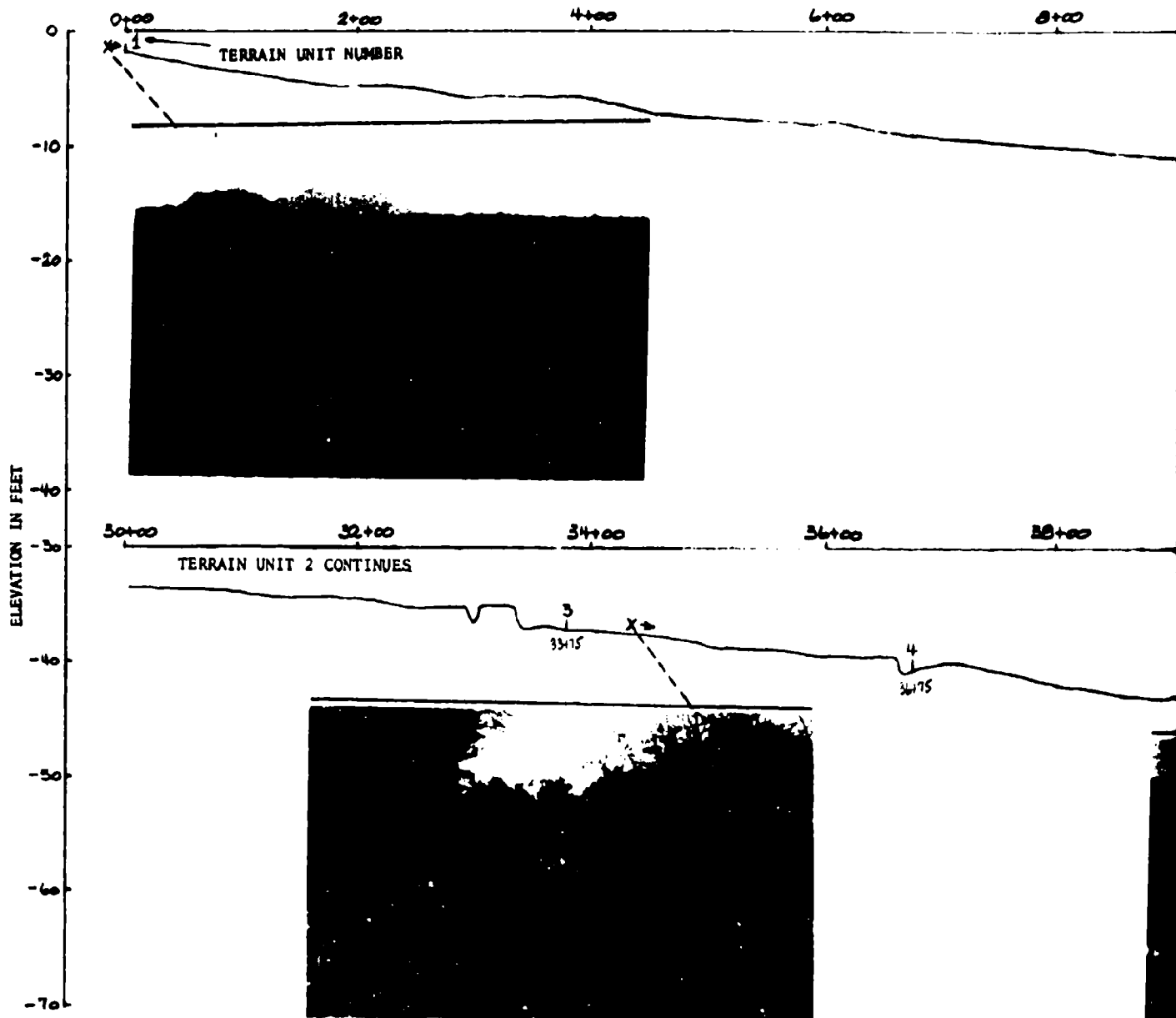
Traverse

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89+71 Traverse 3 Profile Ends

MOBILITY TEST COURSE
VIEWS AND PROFILES
YUMA, ARIZ.
TRAVERSE 3

0



10+00

12+00

14+00

16+00

STATIONS

18+00



40+00

42+00

44+00

46+00

48+00

X→

2

15.15

X→
5
42.15



20+00

22+00

24+00

26+00

28+00

30+00



X→

50+00

52+00

54+00

56+00

58+00

60+00

X→



24+00

26+00

28+00

30+00



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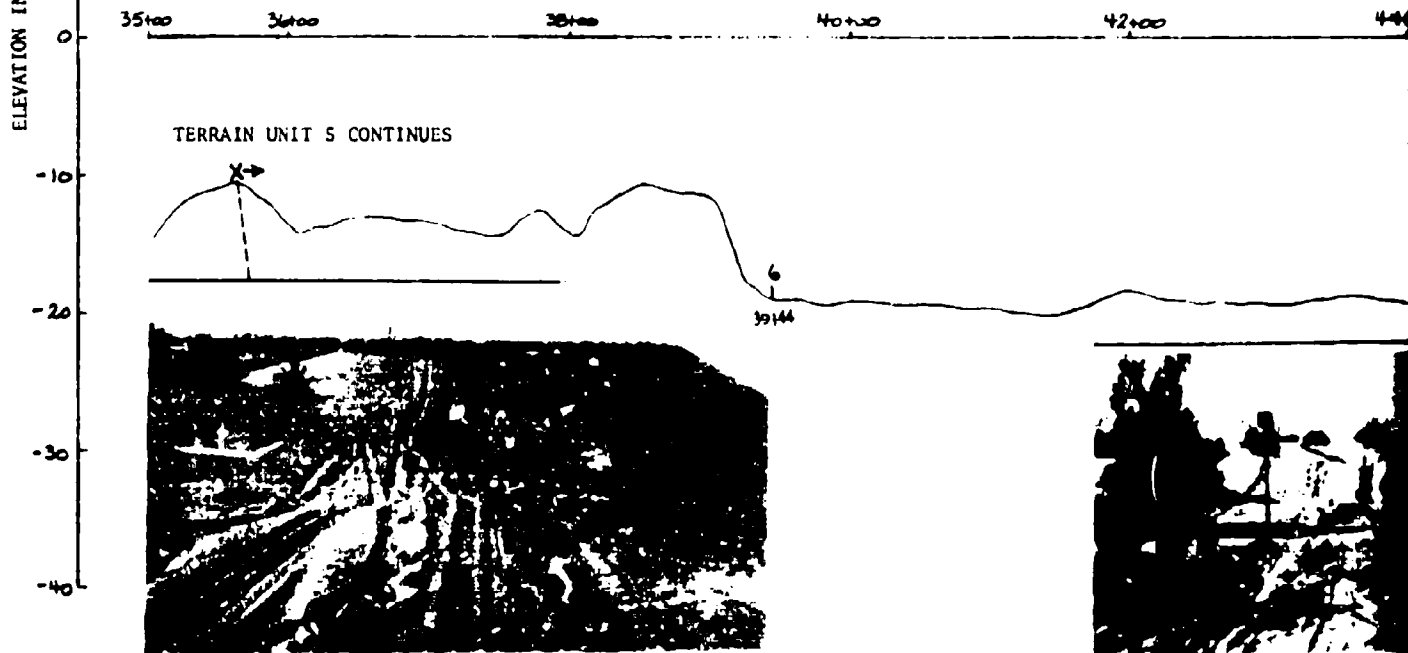
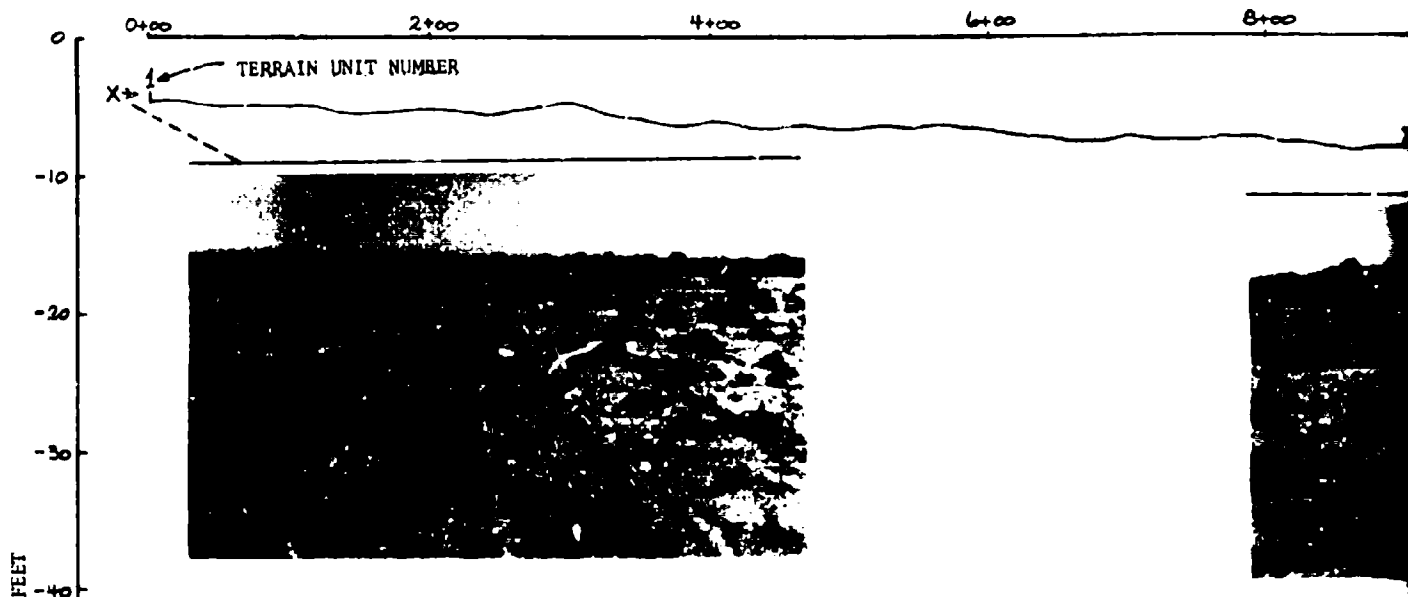
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MOBILITY TEST COURSE
VIEWS AND PROFILES
YUMA, ARIZ.
TRAVERSE 4

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STATIONS

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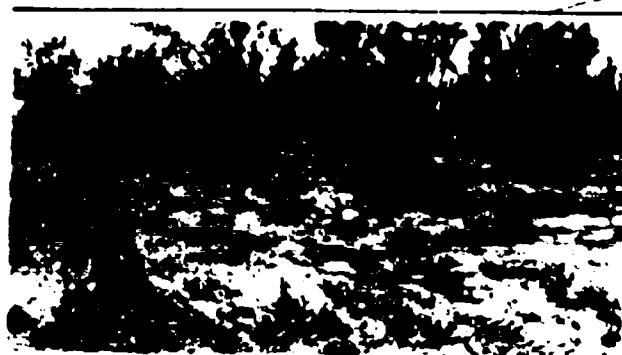
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X=

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MOBILITY TEST COURSE
VIEWS AND PROFILES
YUMA, ARIZ.
TRAVERSE 5

STATIONS

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13

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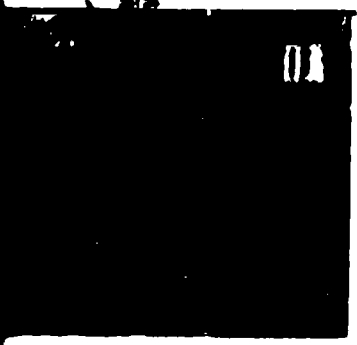
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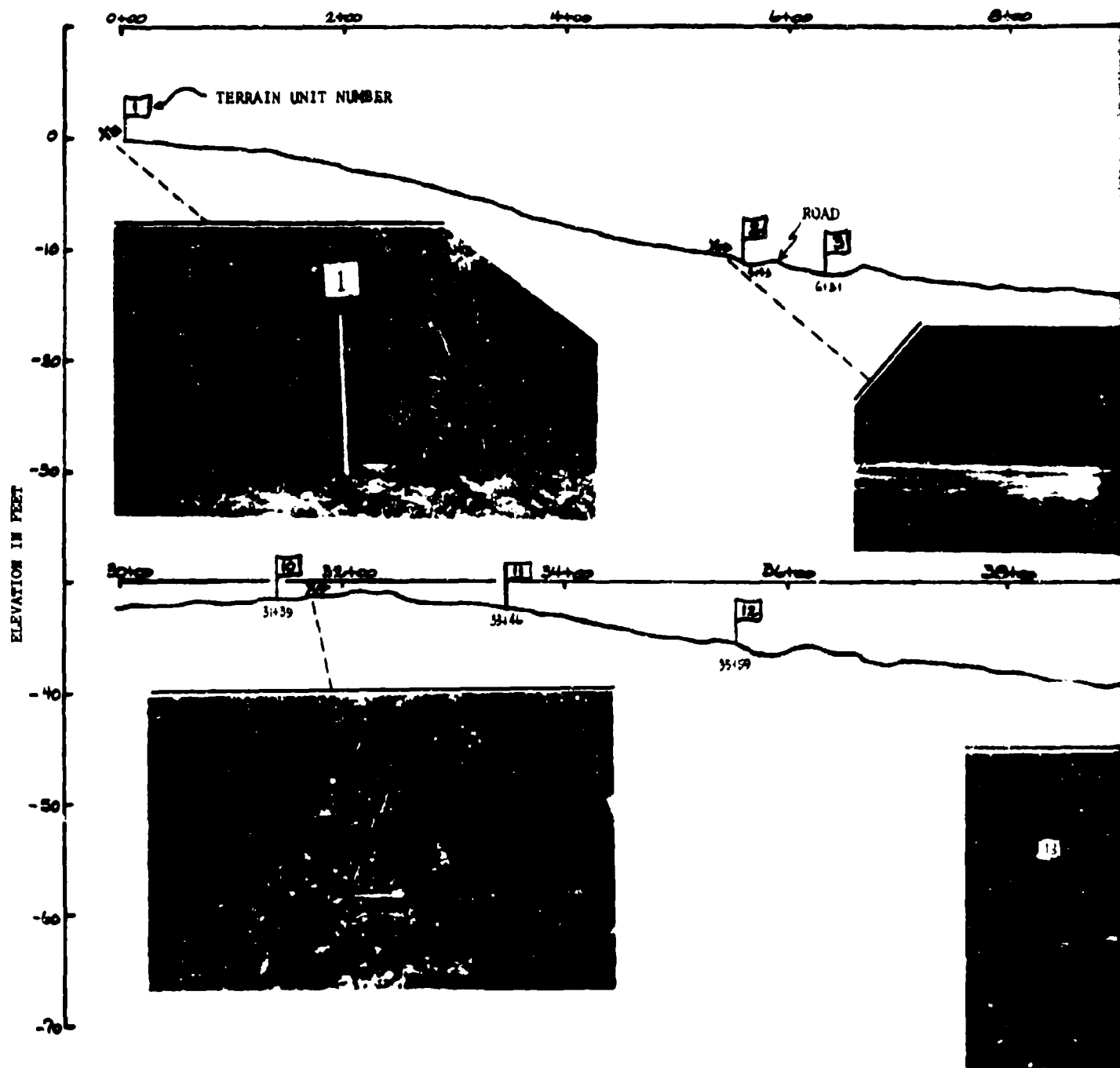
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MOBILITY TEST COURSE
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EGLIN AFB, FLA.
TRAVERSE 1



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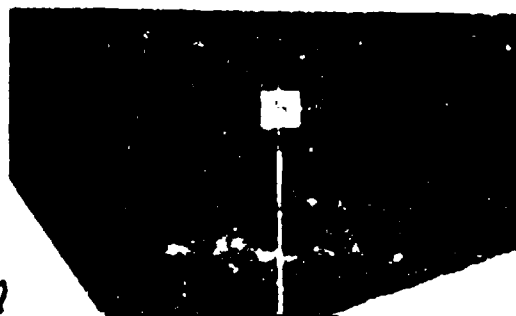
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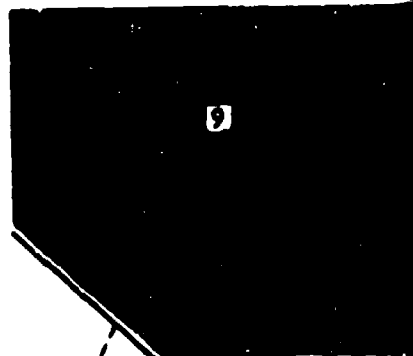
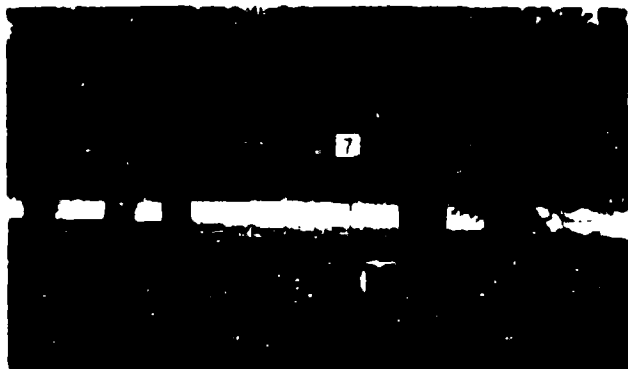
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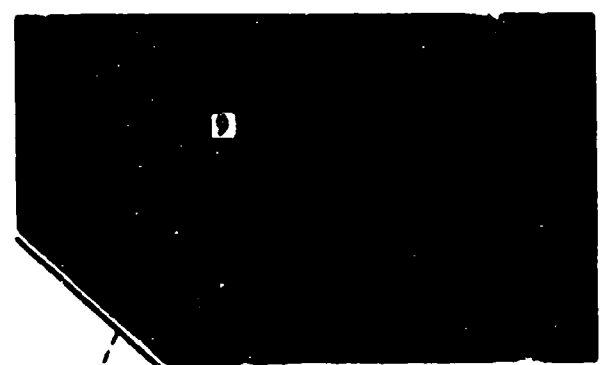
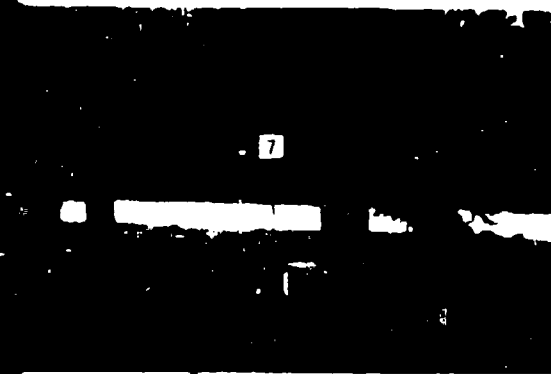
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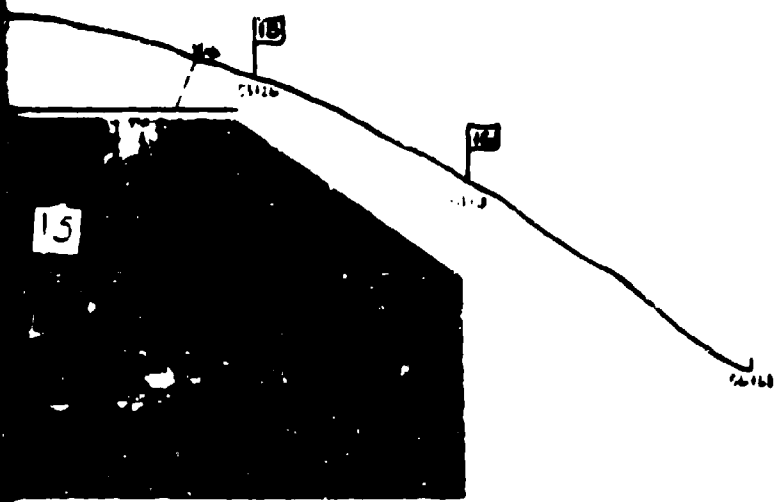
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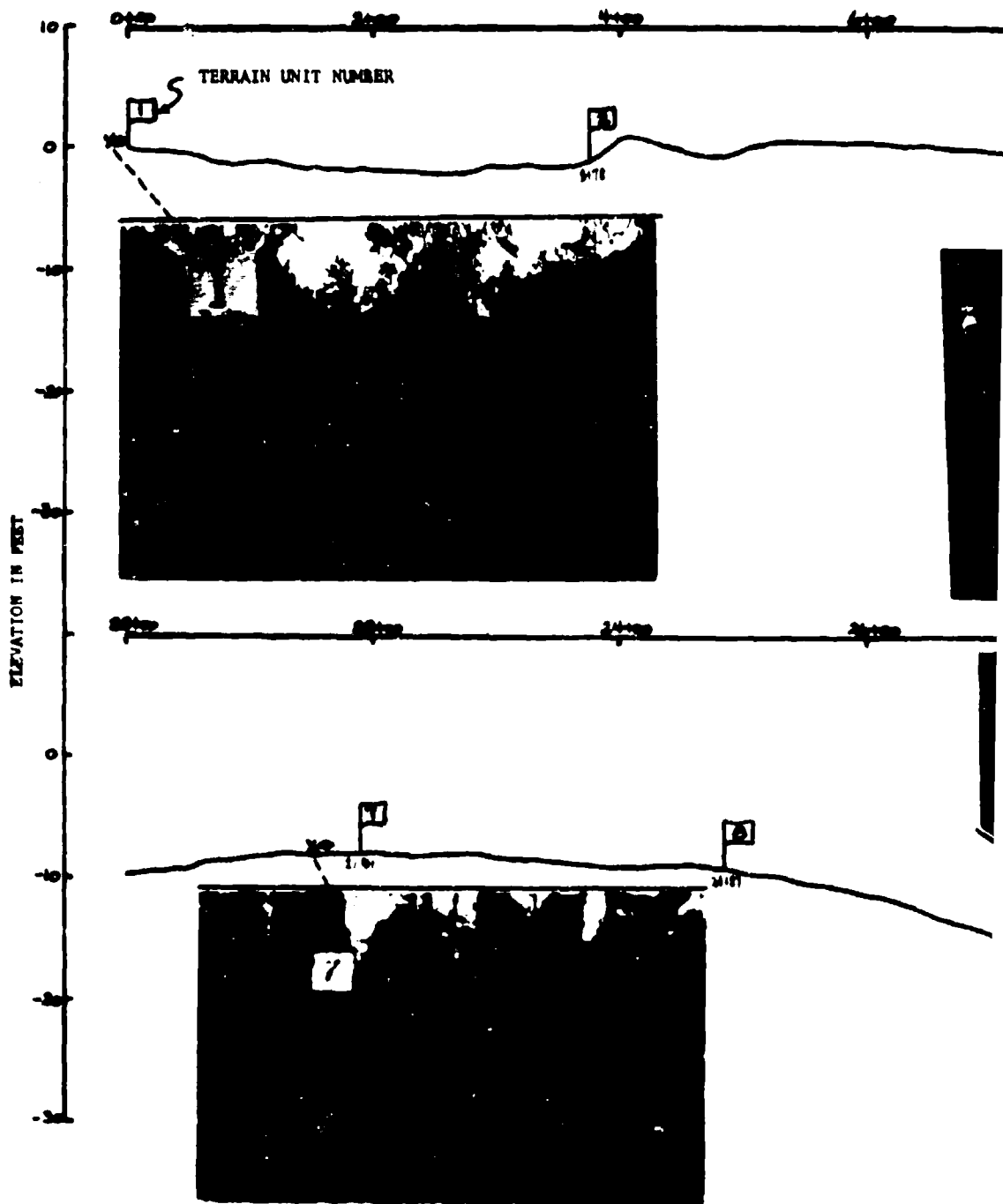
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MOBILITY TEST COURSE
VIEWS AND PROFILES
EGLIN AFB, FLA.
TRAVERSE 2



STATIONS

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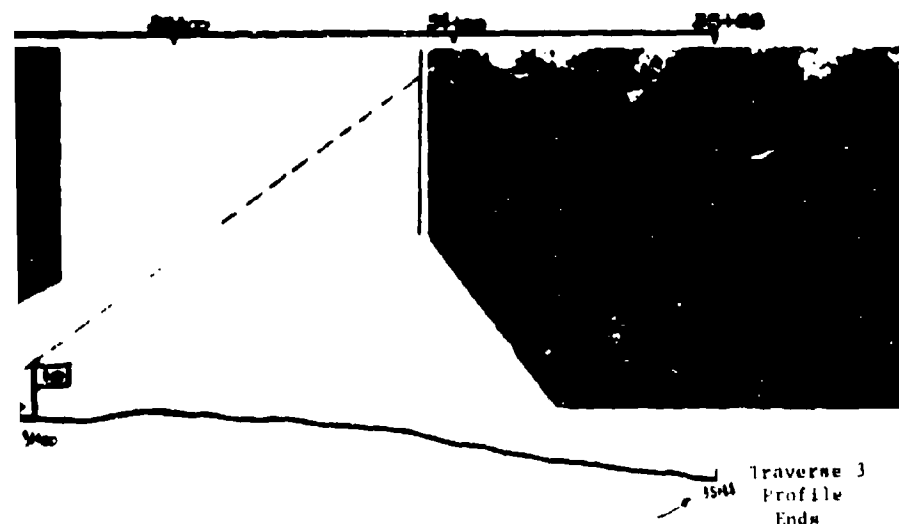
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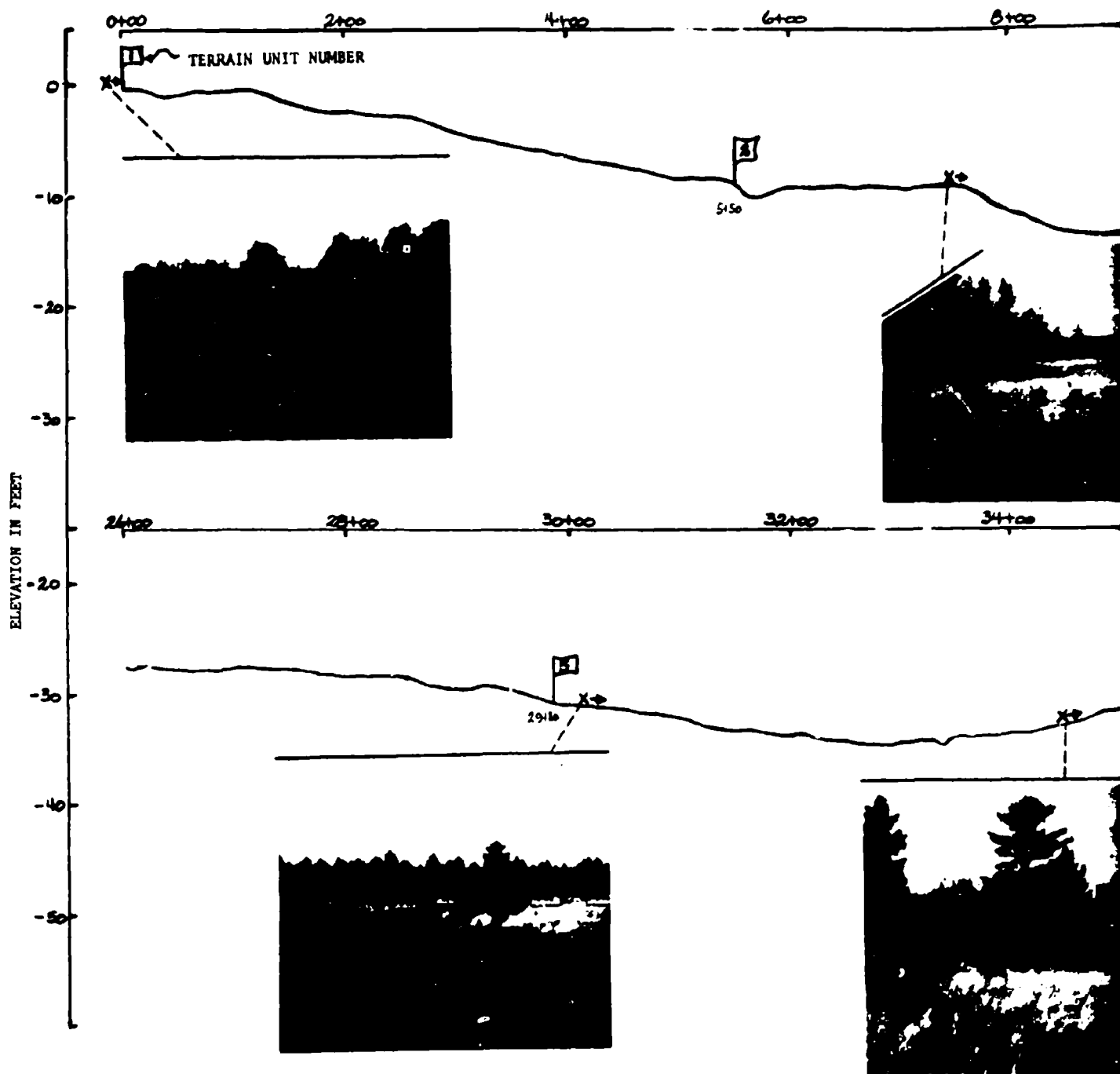


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MOBILITY TEST COURSE
VIEWS AND PROFILES
EGLIN AFB, FLA.
TRAVERSE 3

33<

PLATE B12



STATIONS

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16+00

18+00

13+00

36+00

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42+00

44+00

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ROAD

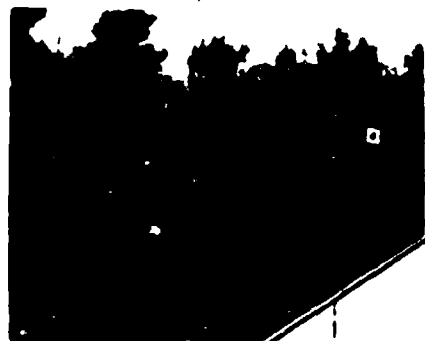
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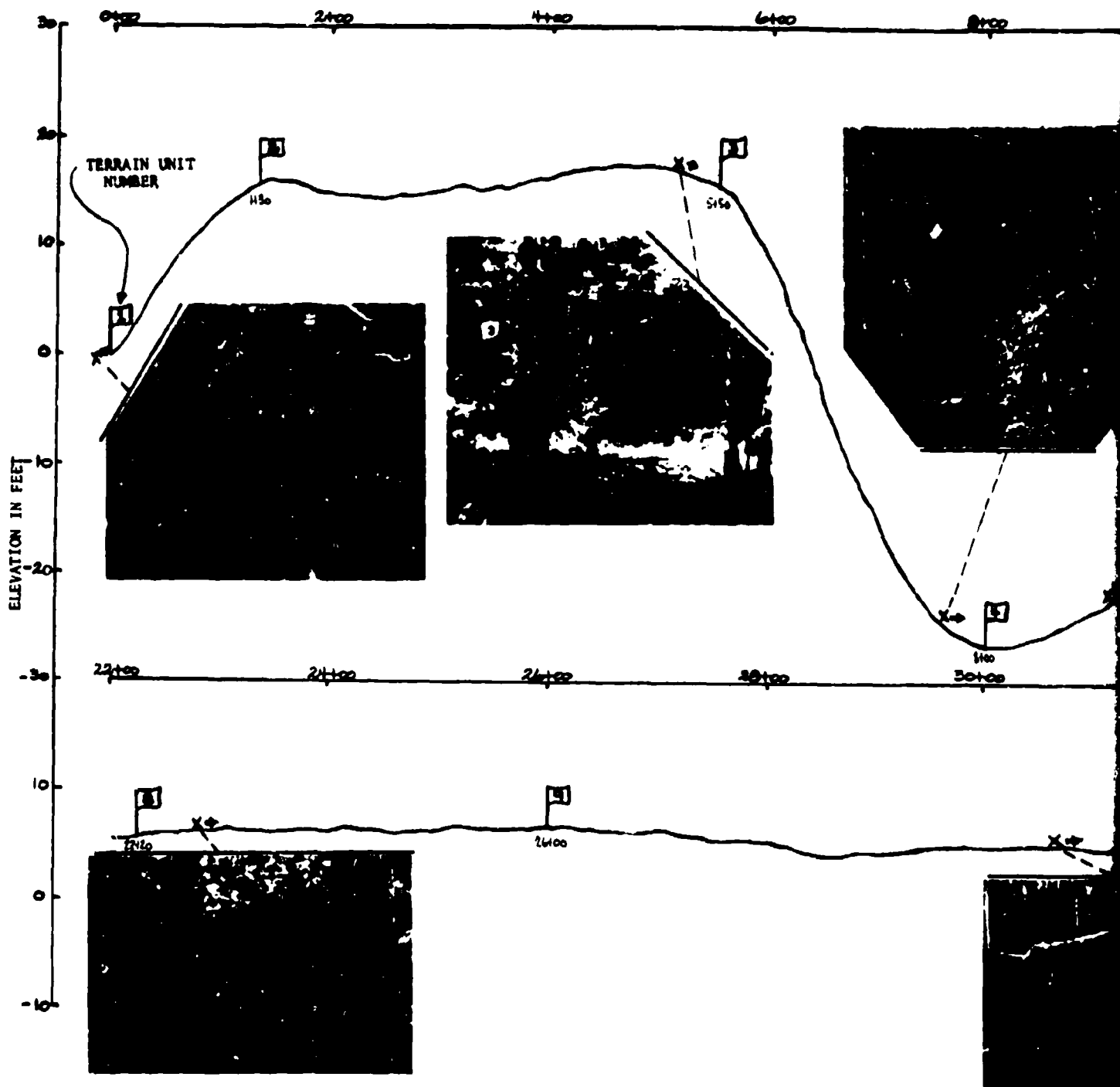
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MOBILITY TEST COURSE
VIEWS AND PROFILES
HOUGHTON, MICH.
TRAVERSE 1



STATIONS

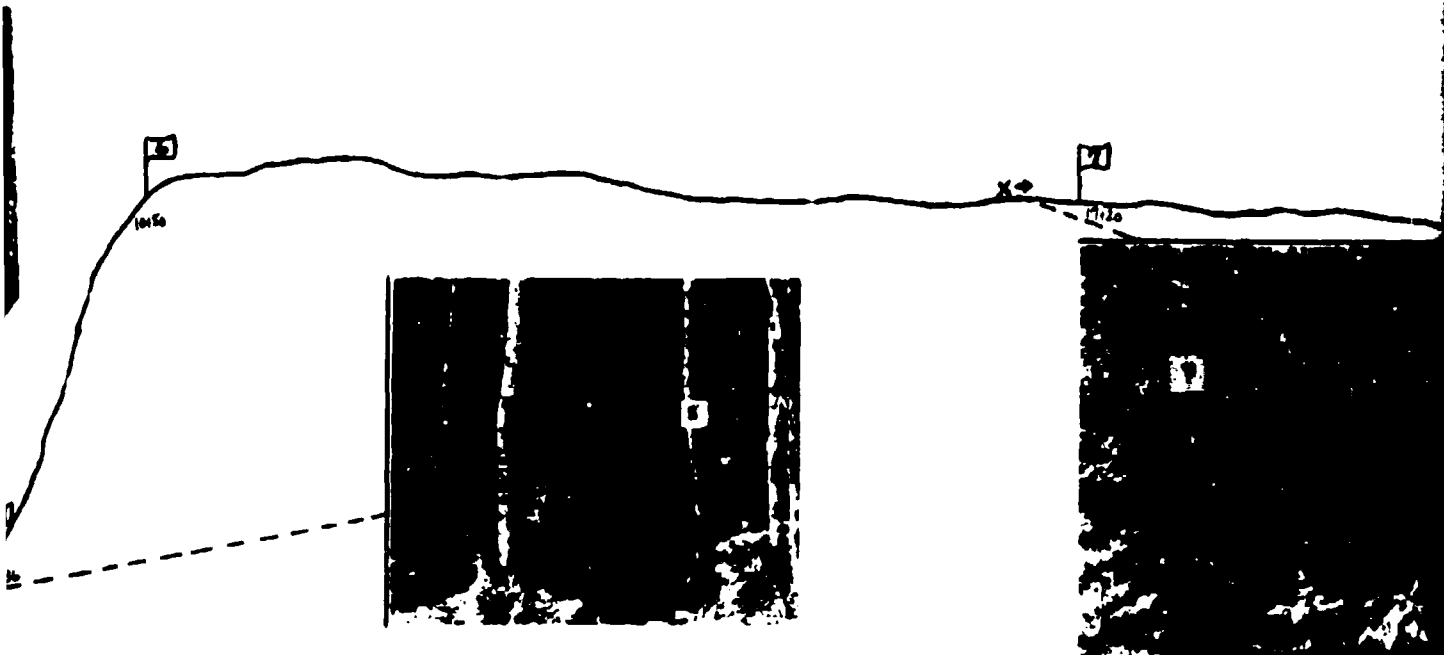
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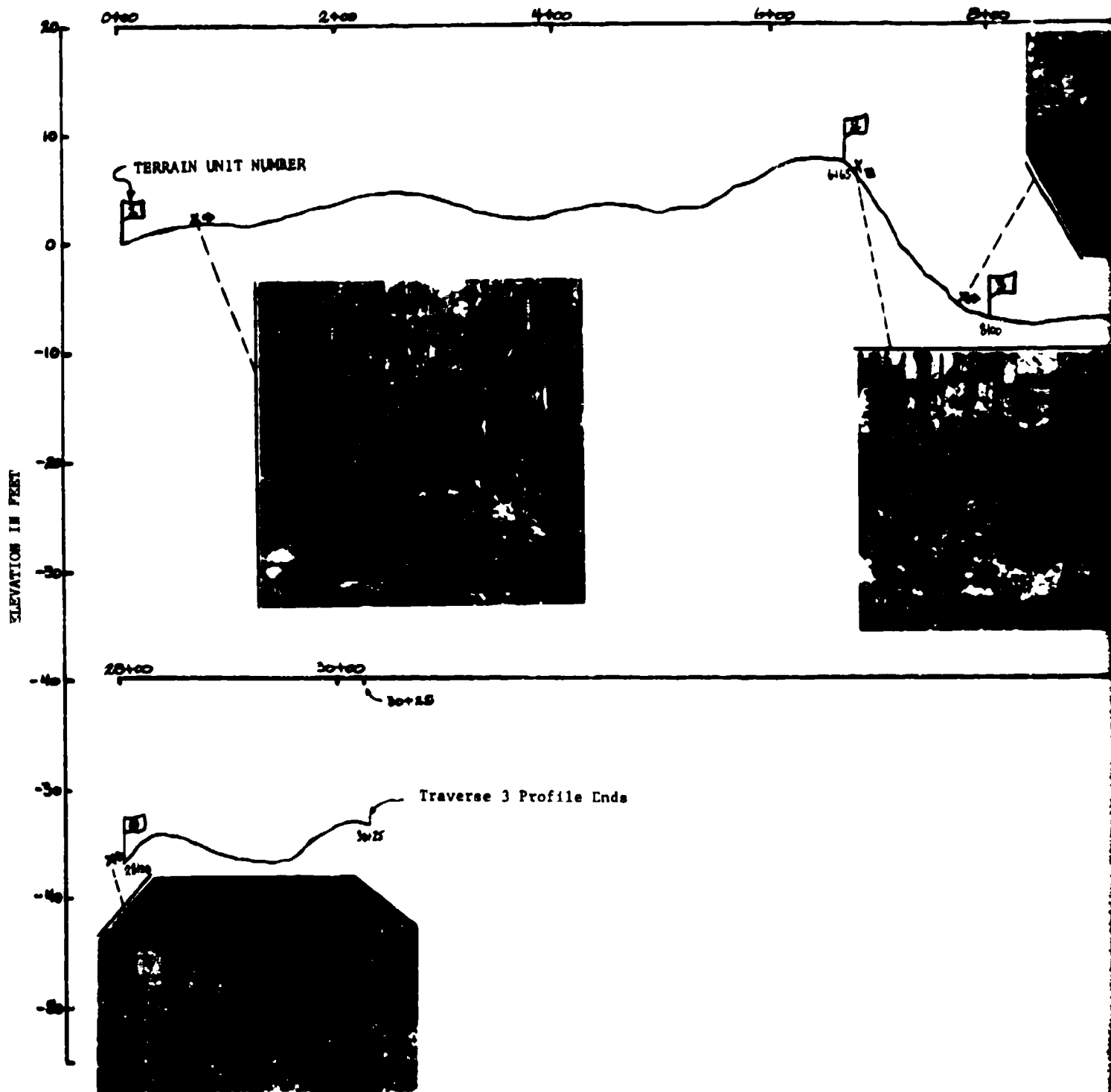
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MOBILITY TEST COURSE
VIEWS AND PROFILES
HOUGHTON, MICH.
TRAVERSE 2

C



10400

12400

14400

STATIONS

16400

18400



1

10400

2

17495



20100

22100

24100

26100

28100



20115



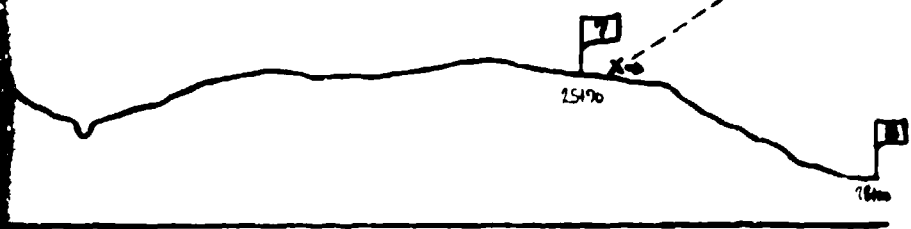
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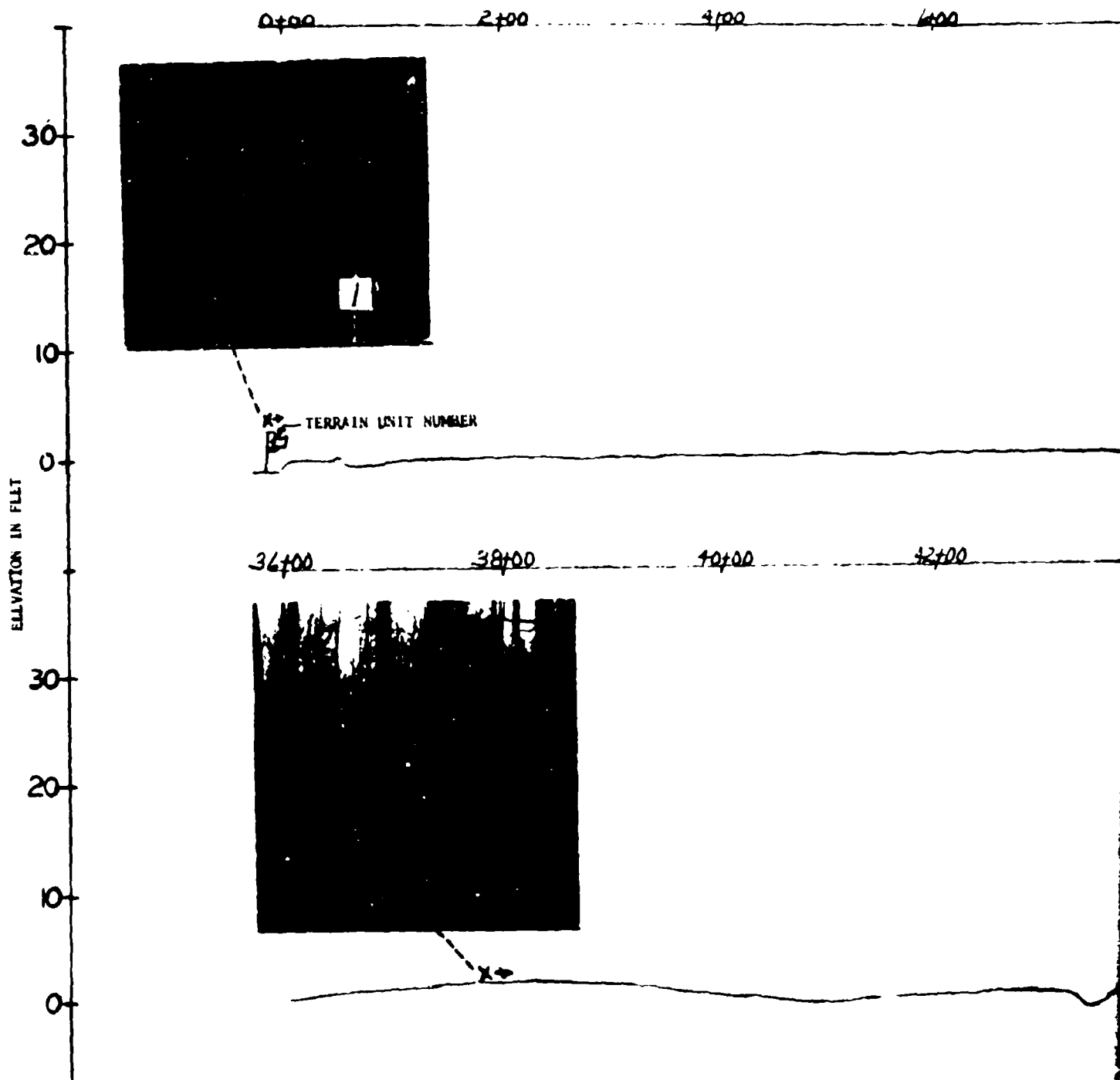
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MOBILITY TEST COURSE
VIEWS AND PROFILES
BOUGHTON, MICH.
TRAVERSE 3



8+00

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STATIONS

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26+00

18+00

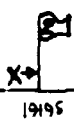
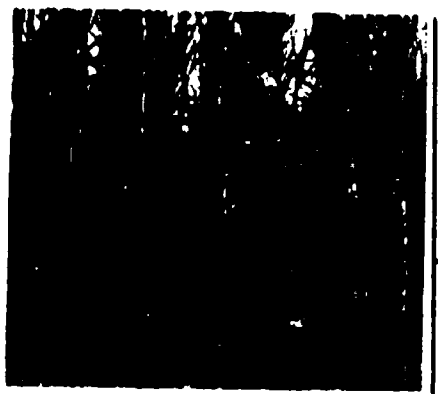
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62+00

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4



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1 C

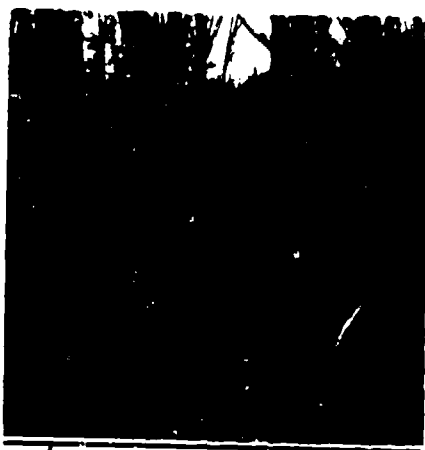
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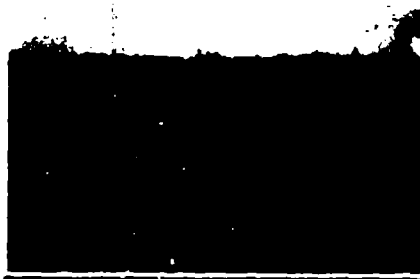
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72+00



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66+00

MOBILITY TEST ON
VIEWS AND PROFILES
FORT KNOX, TENN.
TRAVERSE 1

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42<

PLATE B16 (Sheet

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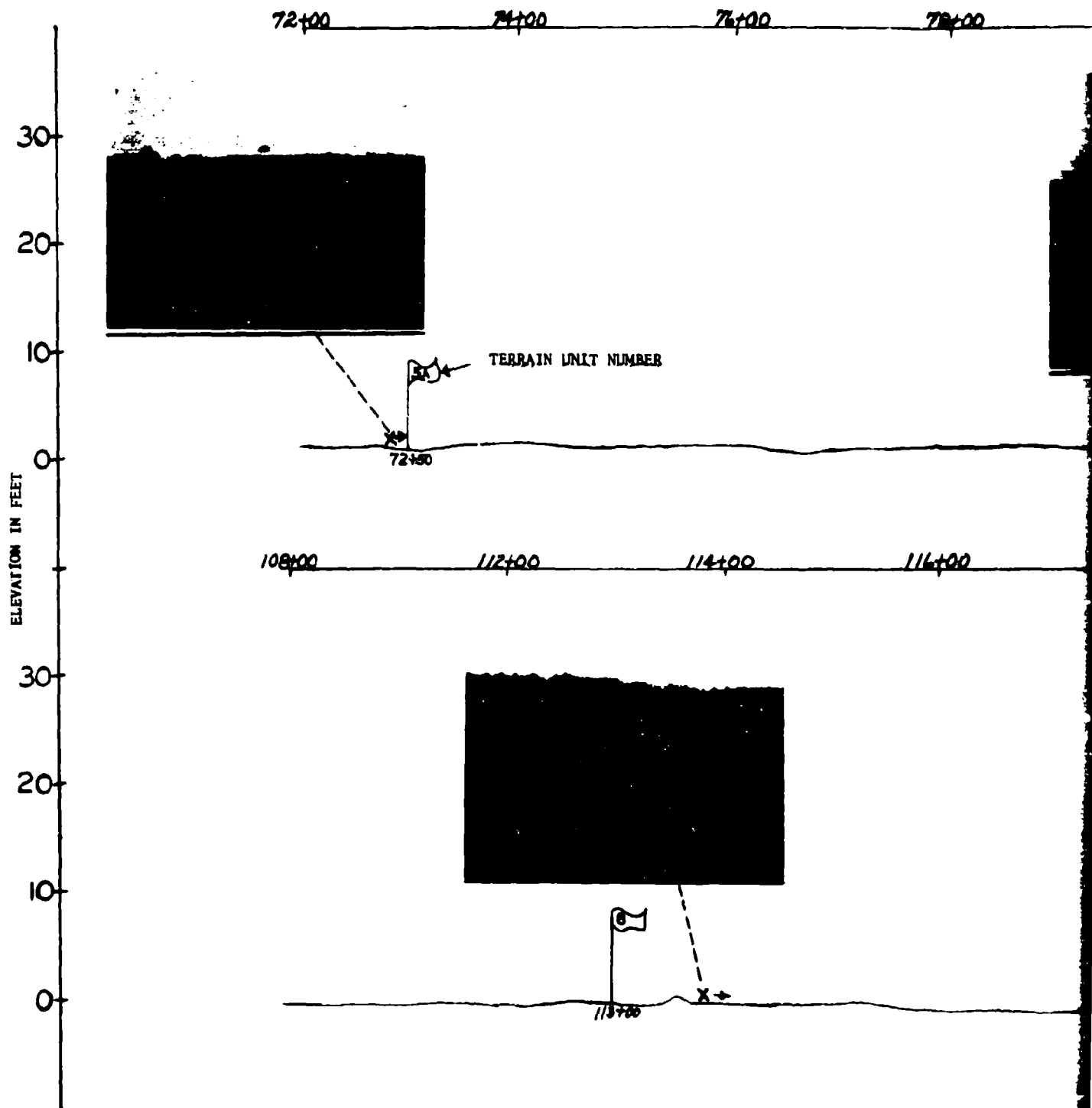
MOBILITY TEST COURSE
VIEWS AND PROFILES
FORT KNOX, KY.
TRAVERSE 1



66+00

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Next Page

E



A

80+00

82+00

84+00

86+00

88+00

STATIONS



X →

Tree used as
turning point

84+00

X →

88+00

118+00

120+00

122+00

124+00

126+00

128+00



122+50

X →

90+00

92+00

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98+00

100+00



128+00

130+00

132+00

134+00

136+00

138+00



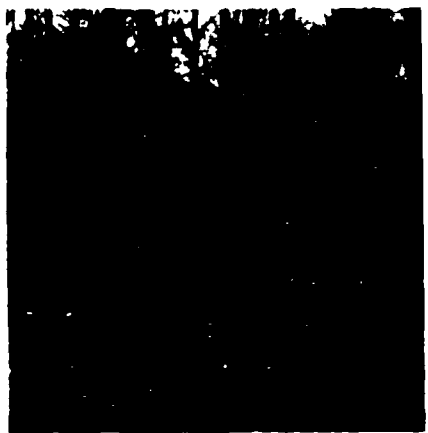
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102+00

104+00

106+00

108+00



Tree used as
turning point



106+28

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138+00

140+00

142+00

142+22



142+22

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MOBILITY TEST COURSE
VIEWS AND PROFILES
FORT KNOX, KY.
TRAVERSE 1

102+00

104+00

106+00

108+00



Tree used as
turning point



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140+00

142+00

142+22

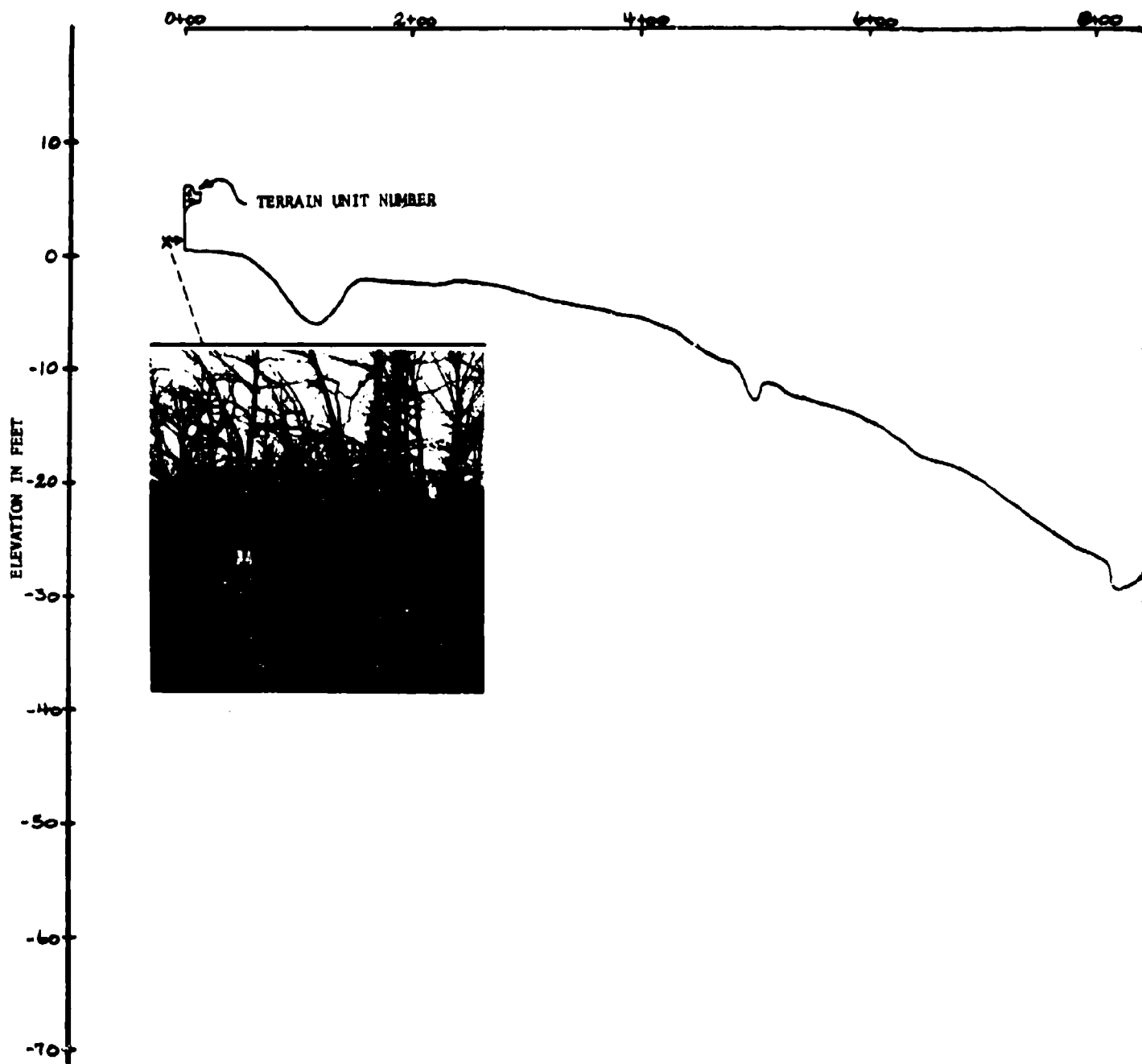


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MOBILITY TEST COURSE
VIEWS AND PROFILES
FORT KNOX, KY.
TRAVERSE 1

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16+00

18+00



X
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TRAIL
11162



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1545

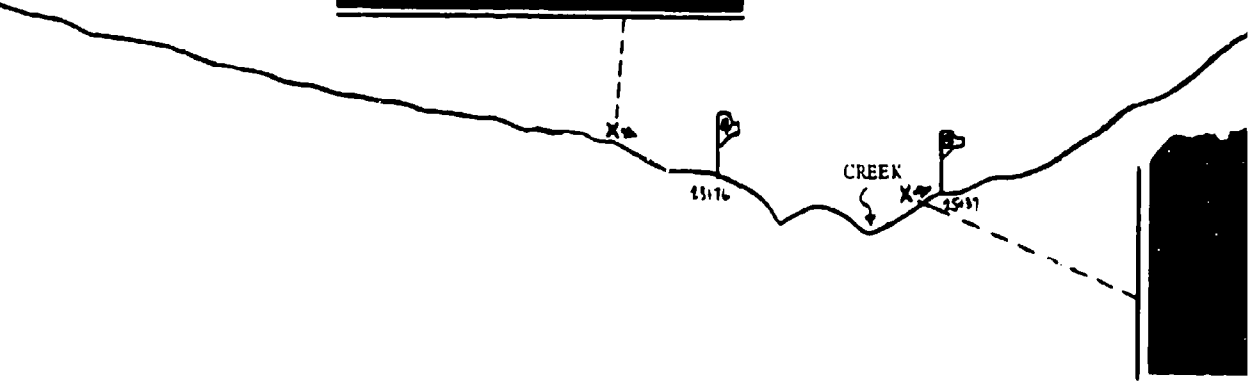
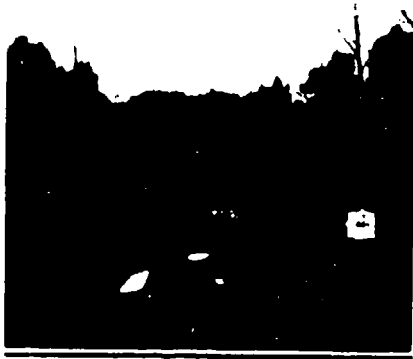
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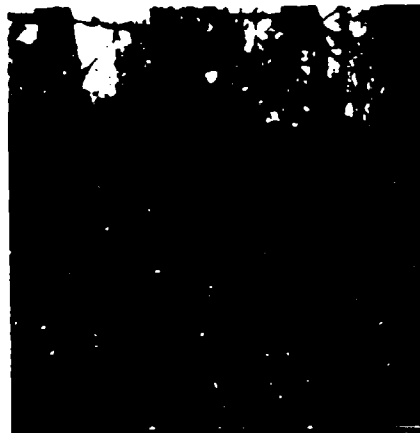
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Profile
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TRAIL
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37+00

MOBILE
VIEWS
FORT
TRAIL

44<

PLATE B17 (Sh

1 D

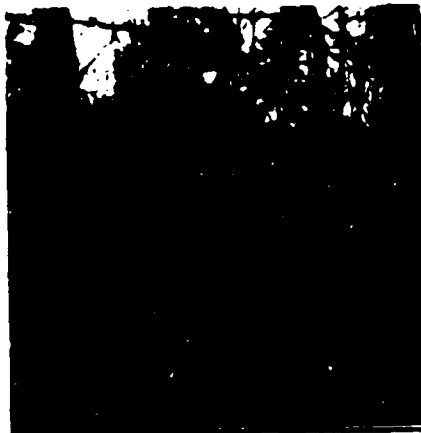
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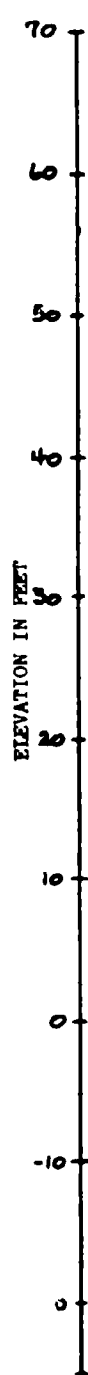
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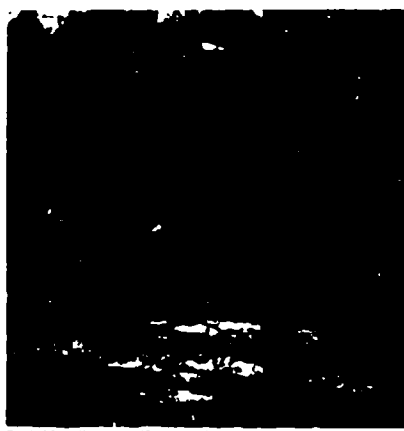
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MOBILITY TEST COURSE
VIEWS AND PROFILES
FORT KNOX, KY.
TRAVERSE 2

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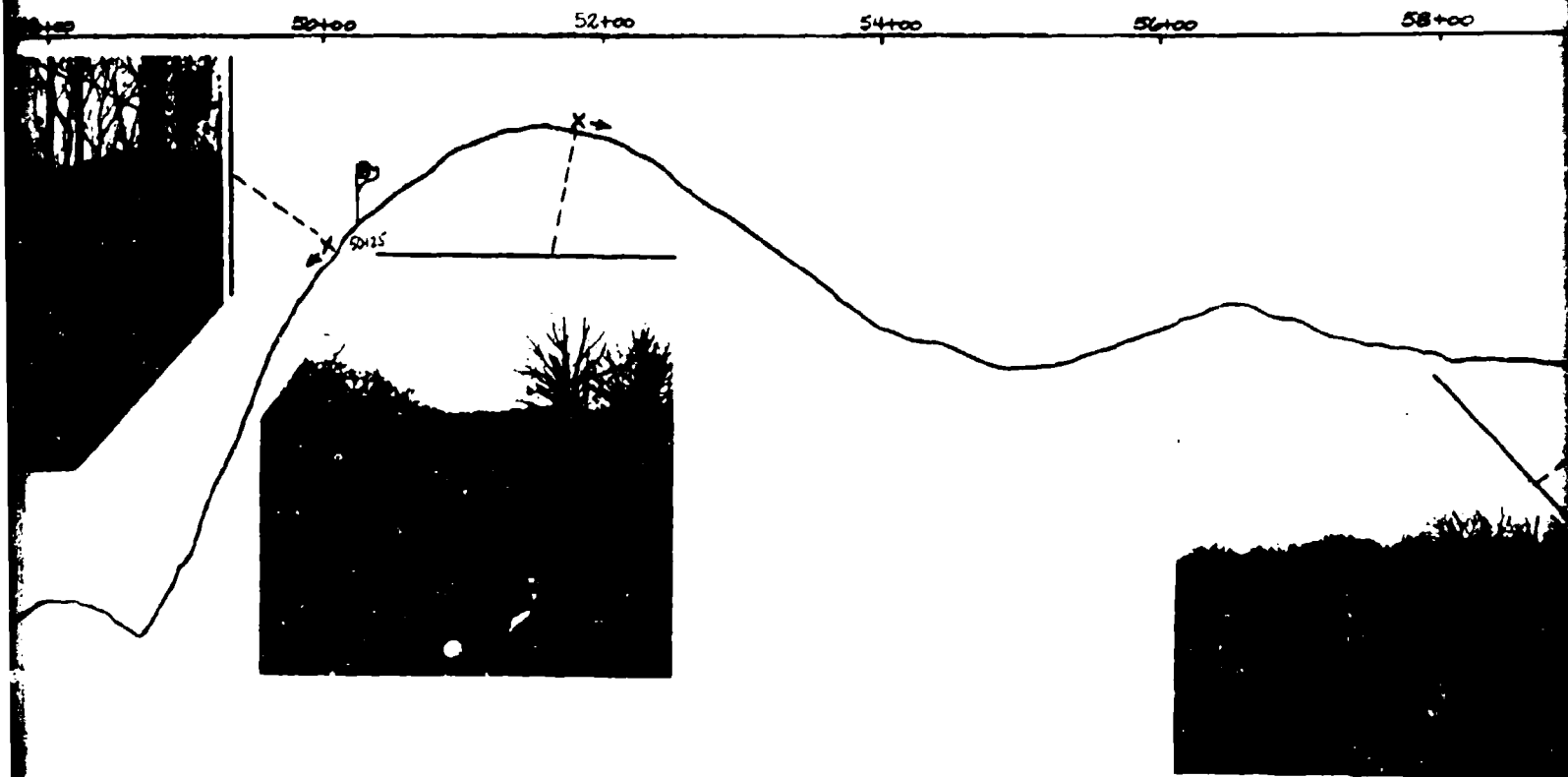
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TERRAIN UNIT
NUMBER

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A

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STATIONS

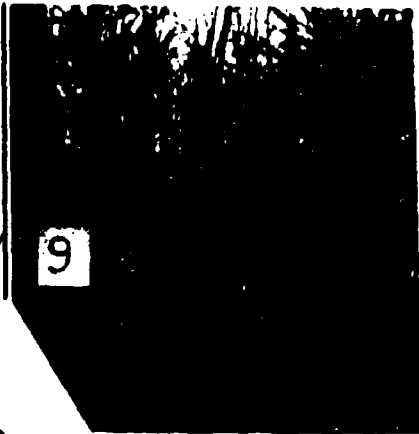
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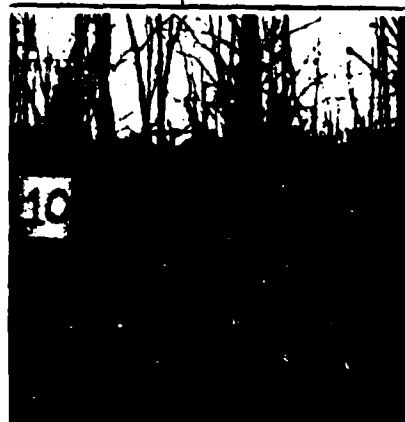
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X
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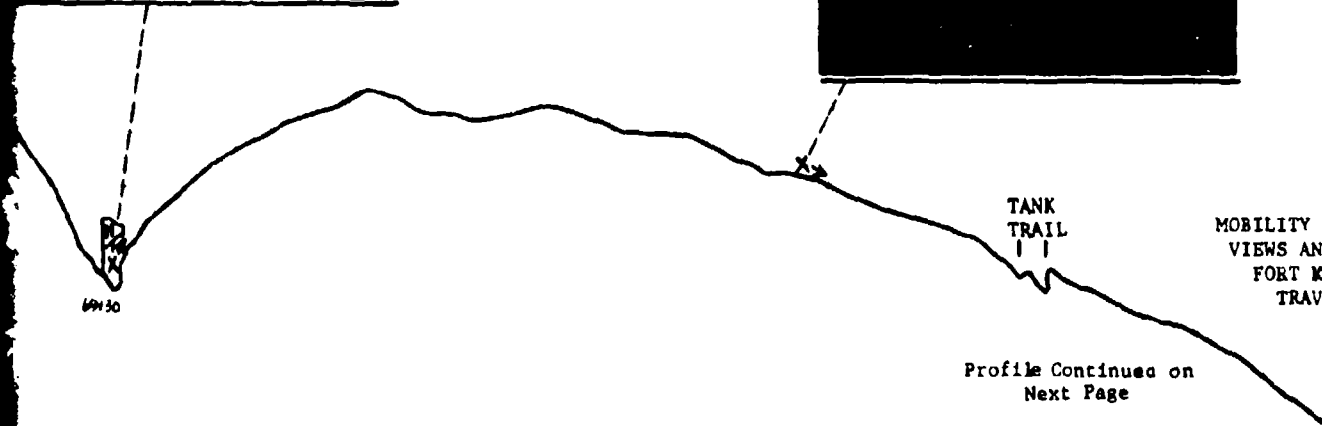
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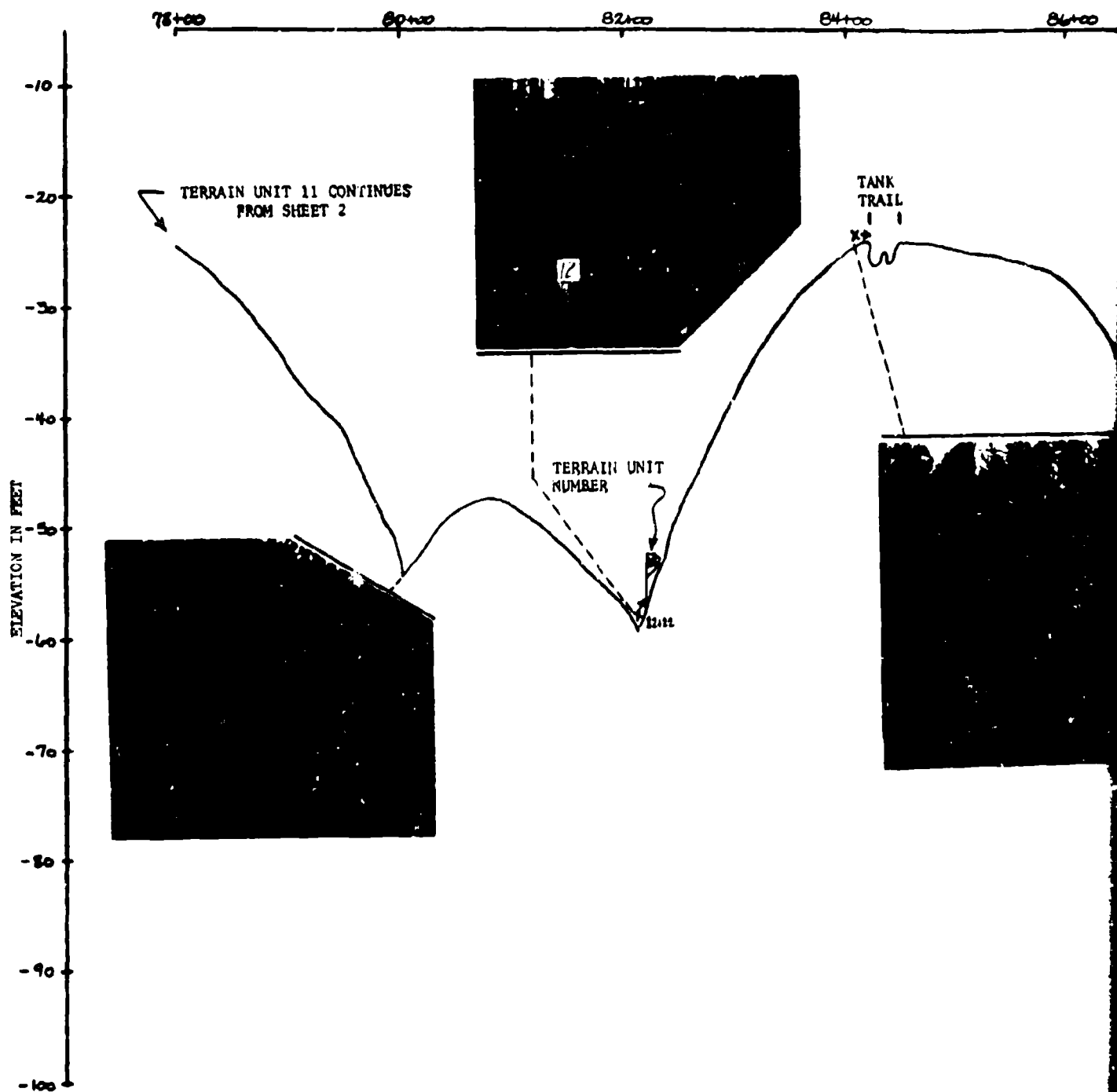
78+00



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TRAIL
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MOBILITY TEST COURSE
VIEWS AND PROFILES
FORT KNOX, KY.
TRAVERSE 2

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88+00

90+00

92+00

94+00

96+00

TANK
TRAIL



TANK
TRAIL.



STATIONS

98+00

100+00

102+00

104+00

106+00



100+50

TANK
TRAIL



104+00

108+00

110+00

112+00

114+00

116+00

117+50

109+50

MOBILITY TEST COURSE
VIEWS AND PROFILES
FORT KNOX, KY.
TRAVERSE 2

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46<

PLATE B17 (Sheet 3 of 3)

APPENDIX C: DEFINITIONS OF TERRAIN TERMS AND PROCEDURES
USED TO COLLECT TERRAIN DATA FOR VALIDATION TESTS

1. This appendix defines terrain terms applicable to mobility and presents procedures for terrain data collection for validation testing.

Definitions

2. General terrain terms are defined as follows:

- a. Terrain factor. Any attribute of the terrain that can adequately be described at any point (or instant of time) by a single measurable value, for example, slope or obstacle height.
- b. Terrain factor value. A specific occurrence of a terrain factor. For example, 2 percent is a factor value of the terrain factor slope.
- c. Terrain factor class (class range). A specified range of factor values established for a specific purpose, for example, a range of slope from 0 to 2 percent.
- d. Terrain factor class number (Figure C1). A number assigned to a terrain factor class range. For mobility purposes, terrain factor class numbers are assigned in order of increasing severity of effect on vehicle performance.
- e. Terrain factor complex number. A combination of two or more terrain factor class numbers chosen for a specific purpose.
- f. Terrain unit. A patch (areal) or length (linear) of homogeneous terrain as defined by a specific array of terrain factors.
- g. Terrain factor map. A map showing the terrain factor class number associated with specific map coordinates.
- h. Terrain factor group map. A map showing a series of terrain factor class numbers associated with specific map

Terrain Factors	Class Numbers													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Surface Type	Fine-Grained Soil	Coarse-Grained Soil	Muskeg											
Surface Strength (CI or RCI)	>280	221-280	161-220	101-160	61-100	41-60	33-40	26-32	17-25	11-16	0-10	13-25	7-12	0-6
Slope (Z)	0-2	2.1-5	5.1-10	10.1-20	20.1-40	40.1-60	60.1-70	>70						
Obstacle Approach Angle (deg)	178.6-180	180-181.5	175.6-178.5	181.5-184.5	170.1-175.5	184.5-190	158.1-170	190.1-202	149.1-158	202.1-211	135.1-149	211.1-225	90.0-135	226-270
Obstacle Vertical Magnitude (in.)	0-6	6.1-10	10.1-14	14.1-18.0	18.1-23.6	23.7-33.5	>33.5							
Obstacle Base Width (in.)	>47	36.1-47	24.1-36	12.1-24	0-12									
Obstacle Length (ft)	0-1	1.1-3.3	3.4-6.6	6.7-10.0	10.1-19.9	20.0-492	>492							
Obstacle Spacing (ft)	>197.0	65.7-197.0	36.4-65.6	26.5-36.3	18.3-26.4	13.4-18.2	8.3-13.3	0-8.2						
Obstacle Spacing Type	Random	Linear												
Surface Roughness	0-0.4	0.5-1.5	1.6-2.5	2.6-3.5	3.6-4.5	4.6-5.5	5.6-6.5	6.6-7.5	>7.6					
Stem Diameter (in.)	>0.1	>1.0	>2.4	>3.9	>5.5	>7.0	>8.7	>9.8						
Stem Spacing (ft)	>328	65.6-328	36.4-65.5	26.5-36.3	18.3-26.4	13.4-18.2	8.3-13.3	0-8.2						
Visibility (ft)	>164	79.0-164	39.6-78.9	29.8-39.5	20.0-29.7	15.1-19.9	10.1-15.0	5.1-10.0	0-5.0					

Figure C1. Areal terrain factor class numbers

coordinates.

1. Terrain factor complex map. A map showing all pertinent terrain factor class numbers associated with all areal terrain or all linear terrain shown on the map.
- Surface geometry terms used are:
- a. Linear obstacle spacing (LST). Distance between obstacles that cross the entire terrain unit and have a somewhat regular pattern, such as row crops or rice-field dikes.
 - b. Obstacle approach angles (A). The angles formed by the inclines at the base of a positive or top of a negative vertical obstacle that a vehicle must sense in surmounting the obstacle (Figure C2).
 - c. Obstacle base width (WB). The distance across the bottom of the obstacle (Figure C2).
 - d. Obstacle length (OBL). The length of the long axis of the obstacle.
 - e. Obstacle spacing (OBS). The horizontal distance between contact edges of vertical obstacles (Figure C2).
 - f. Obstacle spacing type (OBST). The pattern of obstacle location (linear (a) or random (h)).
 - g. Obstacle vertical magnitude (H). The vertical distance from the base of a vertical obstacle to the crest of the obstacle (Figure C2).
 - h. Random obstacle spacing (RST). Obstacles that do not cross the entire terrain unit and have a somewhat random location, such as stumps or logs.
1. Root mean square (rms) elevation. A measure of surface roughness expressed as the root mean square deviation of the terrain amplitudes of a microsurface profile from the mean. (Because peculiarities occur in natural terrain microprofiles, special data handling techniques are used in preprocessing the profile data.)
 1. Slope. The angular deviation of a surface from the horizontal expressed as a percentage (Figure C2).

- k. Surface roughness. Microvariations of the terrain surface that adversely affect vehicle ride dynamics.

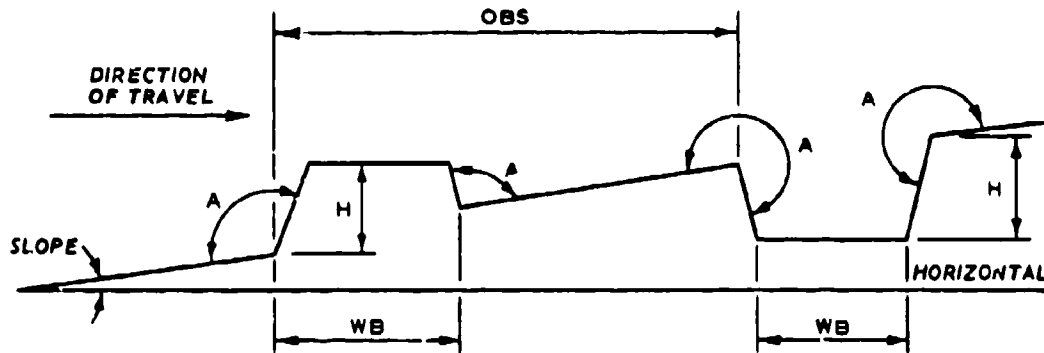


Figure C2. Illustration of obstacle terms

4. Vegetation terms used are:
- a. Recognition distance or visibility. The distance at which a vehicle driver can see through vegetation and recognize objects that may be hazardous to his vehicle or to himself.
 - b. Stem diameter. The diameter of the tree stems at breast height (4.5 ft) above ground.
 - c. Stem spacing. The average distance between tree stems. This value is computed from the number of stems per unit area.

Procedures Used to Collect Terrain Data
for Validation Tests

5. Specific procedures are used to measure the terrain in terms of surface composition, surface geometry, and vegetation.

Surface composition

6. The data collected to characterize surface composition are described in the following paragraphs.

7. Type of surface material. The type of surface material in terms of fine-grained, coarse-grained, or organic soil is identified for the 0- to 6- and 6- to 12-in. layers.

8. Strength. Cone index is measured in undisturbed terrain at a minimum of 10 locations in each terrain unit. Measurements are made at the surface, at 1-in. vertical increments to a depth of 6 in., and then at 3-in. vertical increments to a depth of 18 in. In fine-grained soil, remolding indexes were determined for the 0- to 6- and 6- to 12-in. layers within each terrain unit at the weakest points in the unit as determined by the cone index data. The number and location of soil strength measurements ensured that the average strength of each terrain unit is characterized.

9. Atterberg limits and mechanical properties. Representative samples are taken from the 0- to 6- and 6- to 12-in. layers for laboratory determination of Atterberg limits and mechanical properties.

10. Moisture content and density. Moisture content and density samples are taken at the remolding index locations. Samples were taken from the 0- to 6- and 6- to 12-in. layers.

Surface geometry

11. Surface geometry data collected consists of macrogeometric and microgeometric measurements. The macrogeometric data are used to determine terrain unit slope, and the microgeometric data are used to characterize surface roughness and discrete obstacles in each terrain unit.

12. Slope. Sufficient vertical profile was measured with a rod, level, and tape along the center line of the traverse to determine average terrain unit slope. However, if the test director had reason to believe that one test course profile is not adequate to define the course for all vehicle test paths, additional profiles are measured as required.

13. Surface roughness. Detailed vertical profiles are measured of sufficient length along the vehicle path (100 ft desired) with a rod, level, and tape at locations representative of each terrain unit.

14. Discrete obstacles. Discrete obstacles within a terrain unit are defined in terms of type (linear or random), size, shape, and spacing. Linear obstacles are those over which a vehicle will have to pass, such as row crops or rice-field dikes, and the pitch motion will usually be excited in striking the obstacle at right angles. Random obstacles are considered to be those that a vehicle might be able to avoid, such as boulders or depressions that are randomly spaced in the terrain.

15. The factors that are measured to describe obstacles are approach angle, vertical magnitude (height), base width, length, and spacing. For linear obstacles, spacing is defined as the average center-to-center distance between obstacles; for random obstacles, mean spacings are computed from data obtained using the sample cell technique,* where cell diameter depends upon including 20 or more obstacles of the size designated as the determinant. In areas of widely spaced obstacles, the maximum sample cell diameter is limited to 250 ft. These data are used to compute average values for the terrain factors measured. One sample cell was taken in a terrain unit containing random obstacles, and sufficient spacings are measured in terrain units containing linear obstacles to establish a reliable average.

Vegetation

16. The data described in the following paragraphs were collected to characterize vegetation in each terrain unit in which vehicle tests were conducted.

17. Type. The type of vegetation was identified as nonwoody (grasses) or woody.

18. Stem size and spacing. Woody vegetation data were collected in at least one location in each terrain unit using the sample cell technique.* These data were used to compute stem size and spacing.

19. Visibility. By procedures derived from research at WES, visibility or recognition distance was measured in each vegetation

* U. S. Army Engineer Waterways Experiment Station, CE, "Environmental Data Collection Methods; Vegetation; Vegetation Structure," Instruction Report No. 10, Vol IV, Instruction Manual 1, May 1968, Vicksburg, Miss.

structural cell: Brown cards of various geometric shapes and with dimensions of approximately 1 ft on the sides were placed upright, with the center of the cards at 1 ft above the ground surface. The maximum distance at which an observer could correctly identify all the cards was recorded and considered the recognition distance.

Other information

20. Still and motion pictures were made as aids in describing the terrain and pertinent terrain-vehicle interactions.

APPENDIX D: BASIC TERRAIN DATA

1. Table D1 shows the specific values of the terrain data collected at each test site for the validation program.
2. Table D2 shows the classed terrain data for each traverse of the validation program.

Table 11

(Continued)

295

1 - 1960
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Table D1 (Continued)

Terrain Unit No.		Terrain Unit Distance	Surface Type	Surface Strength MCL	Slope %	Obstacle Angle Deg.	Obstacle Vertical Magnitude in.	Obstacle Base Width in.	Obstacle Length ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	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(Sheet 2 of 8)

(b)(7)(C); Exemption

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(Continued)

62 ✓

Table III (Continued)

Terra- Unit No.	Terra- Unit Distance ft.	Terra-Force Values										Accepting Distance, ft.
		Surface Strength psi	Slope %	Obstacle Angle Deg.	Obstacle Vertical Height ft.	Obstacle Base Width ft.	Obstacle Length ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	Obstacle Spacing ft.	
10	508	14	8.2	90.8	5.0	5.0	15	35.0	1	5.02	20.15	86
11	1292	1	85	194.0	17.6	45.0	--	315.0	1	2.59	7.2	92
12	1828	1	7.7	199.4	18.6	18.2	--	345.0	1	7.41	4.1	75
13	436	1	12.4	187.0	8.1	12.0	--	157.0	2	5.50	45.0	55
14	445	1	3.2	197.0	5.1	48.0	--	157.0	2	2.53	--	40
15	819	1	7.8	200.0	75.0	48.0	--	157.0	2	--	--	--
1	750	1	346	194.0	11.0	60.0	--	254.0	2	2.12	--	146
2	550	1	346	2.07	--	--	--	--	--	--	--	146
3	260	1	398	0.0	--	--	--	--	--	--	--	146
4	400	1	393	7.5	--	--	--	--	--	--	--	146
5	--	1	341	0.0	18.0	12.0	--	--	--	--	--	146
6	--	1	204	0.0	205.0	26	--	--	--	--	--	146
7	--	1	436	0.0	227.0	37.0	--	--	--	--	--	146
8	--	1	332	0.0	230.5	40.0	--	--	--	--	--	146
9	--	1	429	0.0	211.0	34.0	--	--	--	--	--	146
10	--	1	407	0.0	236.0	34.0	--	--	--	--	--	146

Mrs. E. J. Truitt

Table 82 (Continued)

Terrain Unit No.	Yentian Jester Sample No.										Obstacle										Snow Depth or Same Distance Condition
	Surface Type	Surface Strength	Slope	Obstacle Angle Deg	Obstacle Vertical Height In.	Obstacle Base Width In.	Obstacle Length Ft.	Obstacle Spacing Ft.	Obstacle Spacing Ft.	Obstacle Spacing Ft.	Obstacle Spacing Ft.	Obstacle Spacing Ft.	Obstacle Spacing Ft.	Obstacle Spacing Ft.	Obstacle Spacing Ft.	Obstacle Spacing Ft.	Obstacle Spacing Ft.	Obstacle Spacing Ft.	Obstacle Spacing Ft.	Obstacle Spacing Ft.	
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Pt. Still, Ohio, Transverse 1 (Continued)																					
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
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Yentian, Ohio, Transverse 1																					
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40	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

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(Sheet 2 of 6)

Barbara Dorcas Combs, Jr.

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19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049 1

Table D: (Continued)

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In accordance with BR 70-2-3, paragraph 6c(1)(b), dated 15 February 1973, a facsimile catalog card in Library of Congress format is reproduced below.

Schreiner, Barton G

Validation of the AMC-71 mobility model, by Barton G. Schreiner and William E. Willoughby. Vicksburg, U. S. Army Engineer Waterways Experiment Station, 1976.

2 v. illus. 27 cm. (U. S. Waterways Experiment Station. Technical report M-76-5)

Prepared for U. S. Army Materiel Development and Readiness Command, Alexandria, Virginia, under Project 1G662601AH91, Task 01.

Bibliographical footnotes.

1. AMC-71 Mobility Model. 2. Mobility models.
3. Terrain. 4. Vehicle performance. I. Willoughby, William E., joint author. II U. S. Army Materiel Development and Readiness Command. (Series: U. S. Waterways Experiment Station, Vicksburg, Miss. Technical report M-76-5)
TA7.W34 no.M-76-5